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Fig. 1.

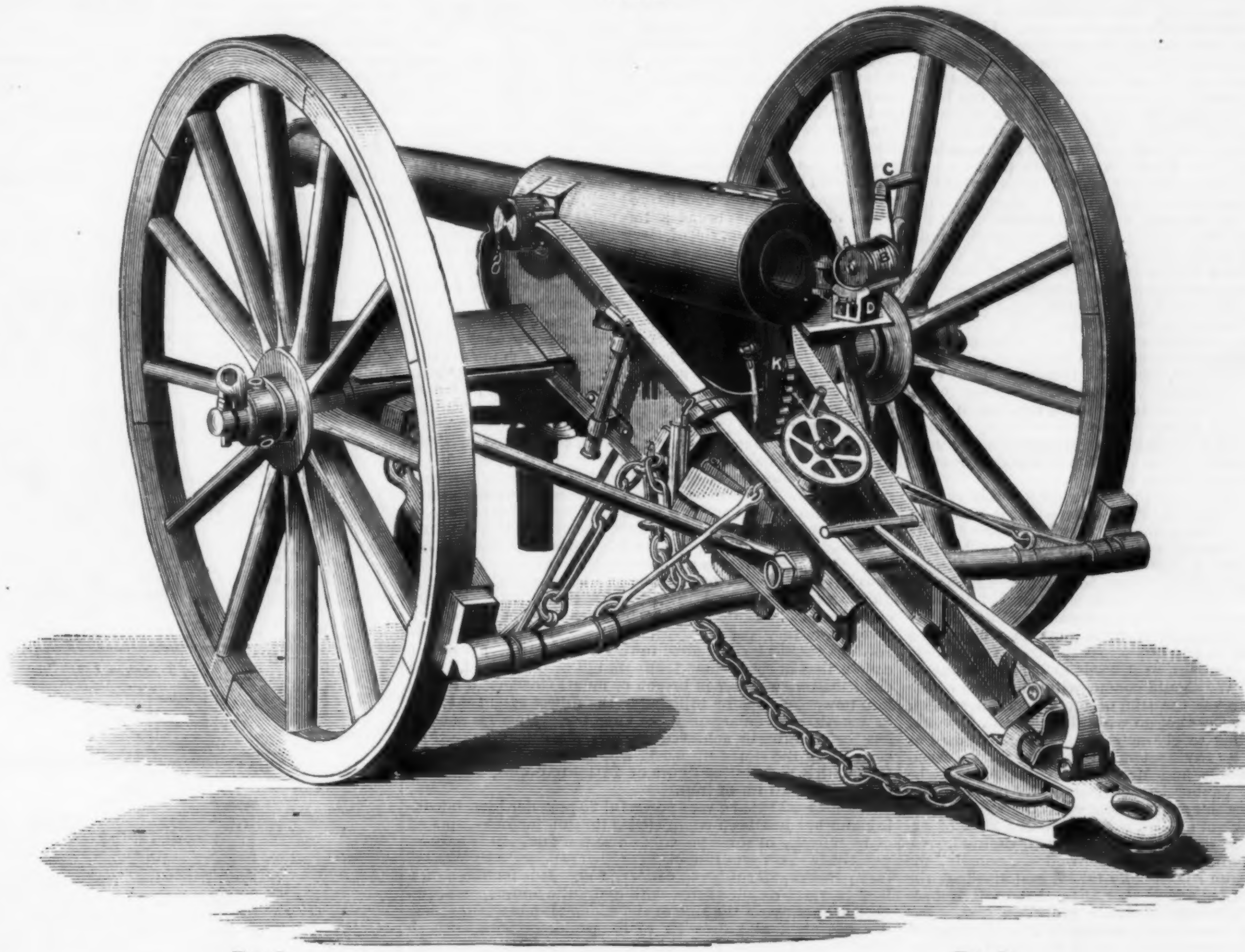


Fig. 2.

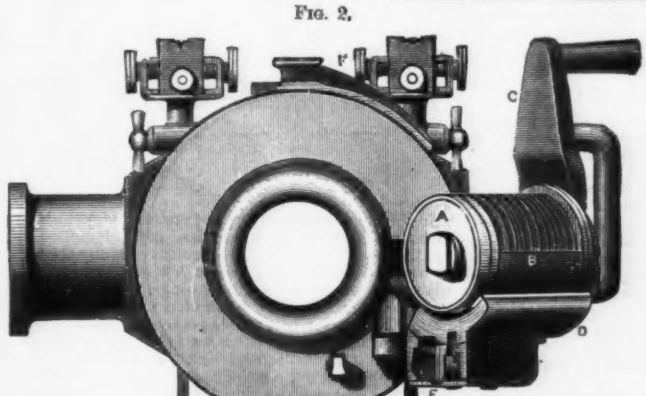


Fig. 3.

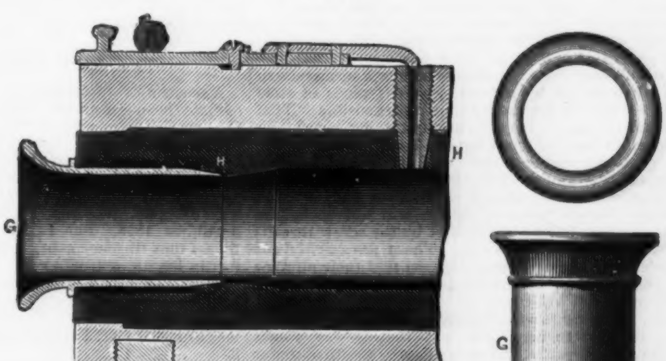
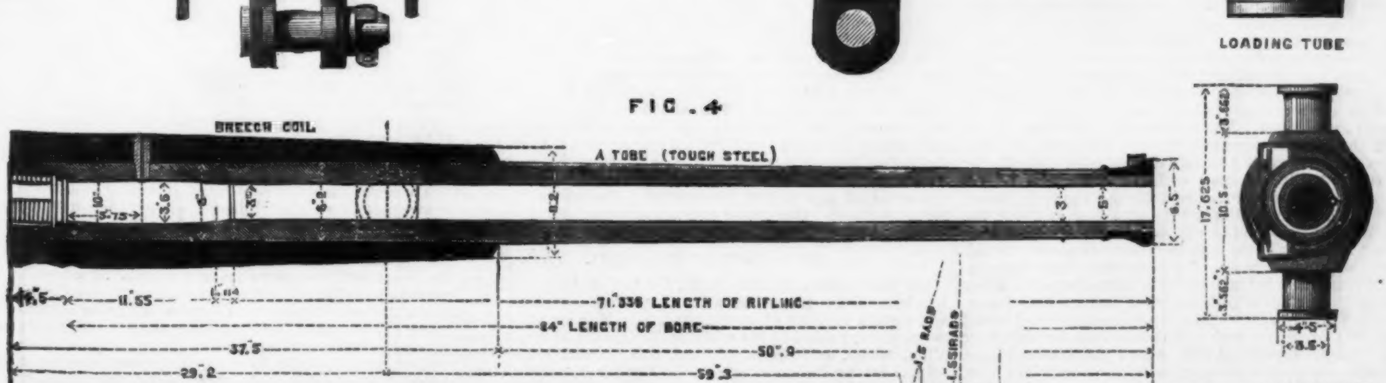


FIG. 4



NEW ENGLISH THIRTEEN-POUNDER BREECH-LOADING GUN.

NEW THIRTEEN-POUNDER BREECH-LOADING GUN.

WE publish complete illustrations of this weapon, recently completed under Colonel Maitland in the Royal Gun Factories, taken from an official photograph of the gun and carriage—*vide* Fig. 1, first page. To this we now add cuts taken from the official lithographs, together with a short account of the design of the gun.

It should be understood that, in general proportions, the gun is not to be regarded as a design embodying the exact idea of our artillery authorities as to what a breech-loading field gun ought to be. These pieces have been constructed in order to enable a comparative trial to be made of field guns issued experimentally to our field batteries, differing only in the fact of some being muzzle-loaders and the others breech-loaders. The design was originally made for a muzzle-loading gun, and the breech-loader was made to correspond, as far as possible, with it. Hence the latter gun is not exactly what it would be if it were an independent design. At the same time, this does not apply to the breech mechanism—which is a very important matter at this time, though by no means the only important one. The breech mechanism is, then, a fair subject for criticism.

Figs. 1 and 2 show the breech open. The breech screw, B, with the obturator cup, A, on it, slides in and out of the breech when in the position shown in Fig. 2, with the lever handle vertical, by means of the provision of the interruptions in the screw-thread. When home, it is tightened and supported by turning it round and causing the threads to engage, when the lever, C, is forced down to the right. When withdrawn, it rests upon the carrier, D, and is held by an automatic locking arrangement, E; the carrier is then turned round on the vertical hinge till it is locked in the position shown in Fig. 2—the locking being specially necessary for guns mounted in boats. There is a sliding vent cover at F, which prevents the possibility of the gun being fired when the breech is imperfectly closed, only uncovering the vent when the lever is down. The obturator cup is that of Captain Andrew Noble. The edge is expanded by the gas against the breech bush or copper ring, H. This system, with the exception of the Noble obturator, is that adopted in France, where it has been found very successful. It is very favorably reported on in this country, and the obturator acts particularly well, the breech bush ring being found not to suffer at all from firing—which modifies the objection we should have been inclined to urge against that ring, namely, the fact that it was only removable by an operation of cutting out.

We have referred to complaints made against this system in the *Times* of October 12. These were that it had been "adopted on the recommendation of military artillerists alone," rather than "examined and reported upon by persons conversant with metallurgy and with engineering," a "common sense precaution," the disregard of which had led to "signal failure," "the whole apparatus being designed on the model of a boy's pop-gun." With this are contrasted the Krupp and Whitworth guns, in which "the breech block slides in and out across the bore, and renders the place which it occupies, as it needs to be, the strongest part of the gun." We should concur with the writer of the above in a wish to see the trial of more than one system, but beyond this we cannot go with him; indeed, it would hardly be too strong to characterize the language used as puerile. Practically any system adopted by Sir W. Armstrong, Captain Noble, and Mr. Rendel cannot soberly be spoken of as not having been examined by persons conversant with engineering, to say nothing of the weight to be given to the French authorities. To follow the kind of expressions quoted in detail would hardly be desirable; we must, however, notice two points dwelt on, namely, the statement that the gun has signally failed, and also that the breech is obviously much weaker than that of Krupp or Whitworth. We will take this latter objection first. The slot, which is cut transversely to enable a wedge to pass through a gun, removes much metal from the tube; how much may be seen by drawing horizontal parallel lines across the breech in Fig. 2 above and below the bore. For the length occupied by the breech wedge, the walls of the gun can only consist of the portions above the upper and below the lower line indicated. How any one can suppose that this wholesale cutting away of the circle of metal can render it when closed by a detached cross piece of steel "the strongest part of the gun," is incomprehensible. That the gun is strong enough we are not questioning. A longitudinal strain, in fact, which is the one here imposed on the piece, is generally the one most easily borne. With the screw system now under trial, on the other hand, the ring of metal is unbroken, so that as a cylinder the gun is complete. If the breech screw yields it will not be by the breech of the gun failing bodily, but by the screw threads themselves in some way yielding. These are greatly cut away as described, but it may be seen that their number may be increased as far as desirable. We cannot, therefore, admit any structural weakness.

To come, however, to the failure spoken of. The circumstance referred to was the fact that it was found that the breech screws had a tendency to turn under the shock of discharge, especially if the gun was fired with brakes put on the wheels to check recoil. In one instance a breech screw was projected 15 ft. to the rear, the screw having turned round far enough to free the interrupted screw threads. This, of course, needs immediate remedy. The tendency to turn is, however, so slight that a locking pin—such as is actually used by the French—would obviate the difficulty, and if made automatic it need cause little trouble. Possibly it might be found preferable for the future to make the pitch of the screw rather less abrupt, but the difficulty is too small to dwell on. The reports sent in by the battery in which the casualty occurred are very favorable as to the breech action, and in firing an initial velocity of 1,600 ft. per second is habitually obtained with the service charge of 3 lb. 2 oz. of R.L.G.$_4$ powder. No difficulty has been found as to erosion of the vent. The rate of firing is about the same with the breech-loading and muzzle-loading 13-pounders. This is generally the case in such small pieces, though possibly the great increase of length might have been expected to turn the balance in favor of the breech-loading gun. The question of additional cover for the detachment is not important in the open, but directly any sort of breast work is employed, or such a device as steel shields on the axletree boxes, breech-loading offers great advantages. Fig. 4 shows the general proportions of the gun. The bore is 84 in. or 28 calibers long, the caliber being 3 in. The diameter of the chamber is 3·5 in. The body of the gun consists of a single breech coil over a tough steel tube, as shown in Fig. 4. The bore is rifled with thirteen grooves, having a uniform twist of 1 in 30 calibers. The total weight of the piece is 8¼ cwt.

The carriage—*vide* Fig. 1—has, like the gun, been spoken of by us before. It is made almost entirely of steel, and the chief peculiarity is that the construction is such that the strain falls on the various parts in the form of tension instead of many being under compression. The carriage shown in the figure has a brake applied to the tire of the wheel, which is of course very effectual and satisfactory if it were not open to the serious objection that it prevents any of the detachment from readily getting in between wheel and breech of gun. The guns issued for trial have only a brake applied to the nave. Another very important feature is the elevating arc. Any increase in length in a gun increases the absolute distance through which the breech has to move in elevating or depressing the piece. Increased speed, therefore, is very desirable, which is accomplished by the substitution of the elevating arc for the screw previously used. Major Nicholson, however, in a paper contributed to the Royal Artillery Institution, has pointed out a source of error in laying the piece, which has crept in, connected with the elevating gear. It appears that the gun is liable to be fired with a direction as much as from ten to thirteen minutes higher than intended. In laying, the muzzle sight is naturally directed below the object and gradually brought up to cover the point aimed at—in other words, the breech is run down, and it is found that during this process it rests against the lower surfaces of the teeth of the arc which are forcing it down, and in this position it remains truly pointed until the friction tube is pressed home, which moves it against the opposite surfaces of the teeth in the arc, that is, as far as the play in the teeth admit. Major Nicholson suggests that this would be remedied by always concluding the operation of pointing the gun by a depression movement. This appears objectionable because the point aimed at would be concealed by the muzzle of the gun until in the actual line of sight. We should have thought it was safer and better to give sufficient preponderance to the gun to overcome the friction at the trunnions, so that it would always rest on the upper surfaces of the teeth of the elevating arc.

Two kinds of shrapnel, one pattern made in the Arsenal and one at Elswick, are issued with common shell, all of 13 lb. weight, and case. The shells have one copper band broken into three by two annular grooves near the base to make it take the rifling. There is no copper ring in front, the windage of the projectile being reduced to 0·02 in., which is still much in excess of that adopted by Krupp in a similar case, who indeed only gives the common shell of his 71-ton gun a windage of 0·3 centimeter, or 0·01 in. Metal time and percussion fuses have been issued, which are well reported on. It is not proposed to discuss the details connected with the sights, with the hinged handspike shown in the cut—which does not find favor, and other minor matters. In conclusion, we may sum up by observing that we believe that most officers competent to form a sound opinion, who have no interest to prejudice them, think highly of this gun. As far as we know, this opinion is supported by civilians also. Both the breech and muzzle loading equipments are very good experimentally. It is right that new features should be embodied in them, and it is a matter of course that in these some faults should be discovered. The chief matter, whether in breech or muzzle loaders, is to obtain powerful guns by utilizing to the fullest extent increase in length and enlargement of chamber. How far success has been hitherto achieved in this piece may be seen by calculating the stored-up work, which comes to 230·8 foot-tons with a penetrating figure of 24·48 foot-tons, sufficient to penetrate 4·1 in. of iron.

We may add that a very powerful 25-pounder breech-loading gun has just been completed at the gun factories, spoken of by mistake in some papers as a 25-ton gun. It is a comparatively short gun intended for boat service; weight, 22½ cwt.; length, 25 calibers; caliber, 4 in. It is mounted on a boat carriage or slide fitted with hydraulic buffers, and compressors acting on the side of the slide. It has a large powder chamber, and fires its 25 lb. projectile with the high velocity of 2,000 ft., in other words the projectile leaves the gun with 693·3 foot-tons stored up work—a penetrating figure of 33·17, and a power of piercing about 6·86 in. of iron.—*The Engineer.*

THE NEW ITALIAN IRONCLAD.

ANOTHER of those huge armaments with which Italy has of late been so amply providing herself was launched at Castellamare, opposite Naples, Italy, on the 29th of September last, and King Humbert's arsenal can now not only boast of having equaled England in the production of a hundred ton gun, but of surpassing her by building the largest ironclad afloat. The Italia, as she has been named, was designed, like the Duilio, by Admiral Brin, and was begun in 1876. She has been built entirely of steel, is of 14,300 tons displacement, is armed with a spur some nine feet in length, and will carry four one-hundred ton guns, in addition to broadside batteries of smaller caliber. The engines have been built by Messrs. John Penn & Sons, and are of 8,000 horse power, working twin screws. Her length is 400 feet, her breadth 75 feet, and her depth nearly 33 feet.

The launch was conducted with considerable ceremony, King Humbert and his Cabinet being present, and H.M.S. Monarch and Thunderer and various other foreign war vessels attending to do honor to the occasion. The vessel having been blessed by the clergy of Castellamare, she was duly named by a daughter of Admiral Acton, the Minister of Marine, who broke the traditional bottle of wine over her bows. The shores were then knocked away, and the vessel at once glided into the water as easily and as steadily as could have been wished. The ceremony over, King Humbert returned to Naples in the Staffeta dispatch boat, escorted by the Italian and British men-of-war. At starting the Italian ships followed the King's vessel, with the British ironclads in the rear, but when half across the bay the order was reversed, and H.M.S. Monarch and Thunderer took the foremost place. Our upper engraving opposite is from the London *Graphic*. The lower picture is from *L'Illustration.*

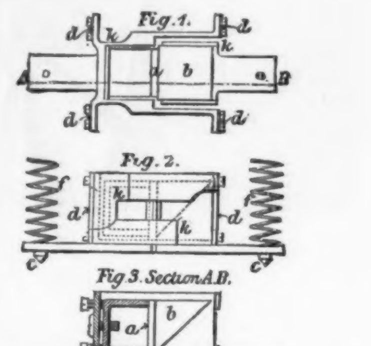
THE LAUNCH OF THE ITALIA.

On Wednesday, the 29th Sept., the Italian ironclad Italia was launched at Castellamare in the presence of the King and a great number of spectators. His Majesty arrived at noon, accompanied by his ministers—Signori Cairoli, Acton, Villa, Miceli, and Baccarini—and was greeted with royal salutes by the Italian squadron, the English ironclads Thunderer and Monarch, a Russian man-of-war, and a Greek corvette. The Italia has already been described in our pages. It may not be out of place to repeat here what we have said concerning her. The principal dimensions are approximately as follows:

Length, 400 feet 3 inches; beam, extreme, 73 feet 10 inches; draught of water, forward, 25 feet 4 inches; aft, 30 feet 4 inches; height of upper deck above keel, 49 feet 3 inches; displacement, 13,480 tons; weight of unarmored hull, 5,000 tons; area of midship section, 1,848 square feet. The double bottom of the ship is 254 feet 3 inches long, 59 feet wide, and 3 feet 3 inches deep, and is divided into a large number of water tight cells. Two longitudinal bulkheads extend from stem to stern, and the ship is divided by means of these and transverse bulkheads into fifty-three water-tight compartments, forty of the latter being above the double bottom of the vessel, three in the rear and ten forward of it. These compartments are again divided horizontally by four water-tight decks; of these, the lowest, which is to be armored with iron 3 in. thick, is about 8 feet 2 inches below the water line; the second, 5 feet above the line of flotation; the battery deck, 14 feet 9 inches, and the upper deck 21 feet 4 inches above the water line. On the upper deck stands an armored redoubt of oval form, its longer axis being at an angle of about 20 degrees to the keel, and within it will be the turrets containing the guns. The armor will be mainly disposed in the form of a girdle around the ship, extending from the deck below to the first deck above the water line. From this latter deck to the upper one the sides of the ship will be consequently unprotected; but the lower chimney, and also the tubes up which the ammunition is passed from the magazine to the redoubt, will be armored. The ship will be driven by twin screws, each 19 feet 6¼ inches in diameter, worked by four engines, intended to work up to 18,000 horse power, and propel the vessel through the water at the speed of 16 knots per hour. Her guns are of the Armstrong manufacture, and each weighs 100 tons. She will carry four of these, besides several of smaller caliber.—*The Engineer.*

STROMEYER'S STRAIN INDICATOR.

MR. STROMEYER'S strain indicator is in principle an instrument for measuring very slight variations in length, made visible by means of the so-called "Newton's rings,"* as they appear when homogeneous light falls on two slightly curved and transparent surfaces placed opposite to each other. It has consequently the advantage of the entire absence of any friction.



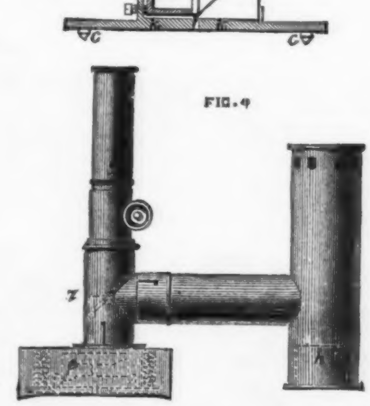
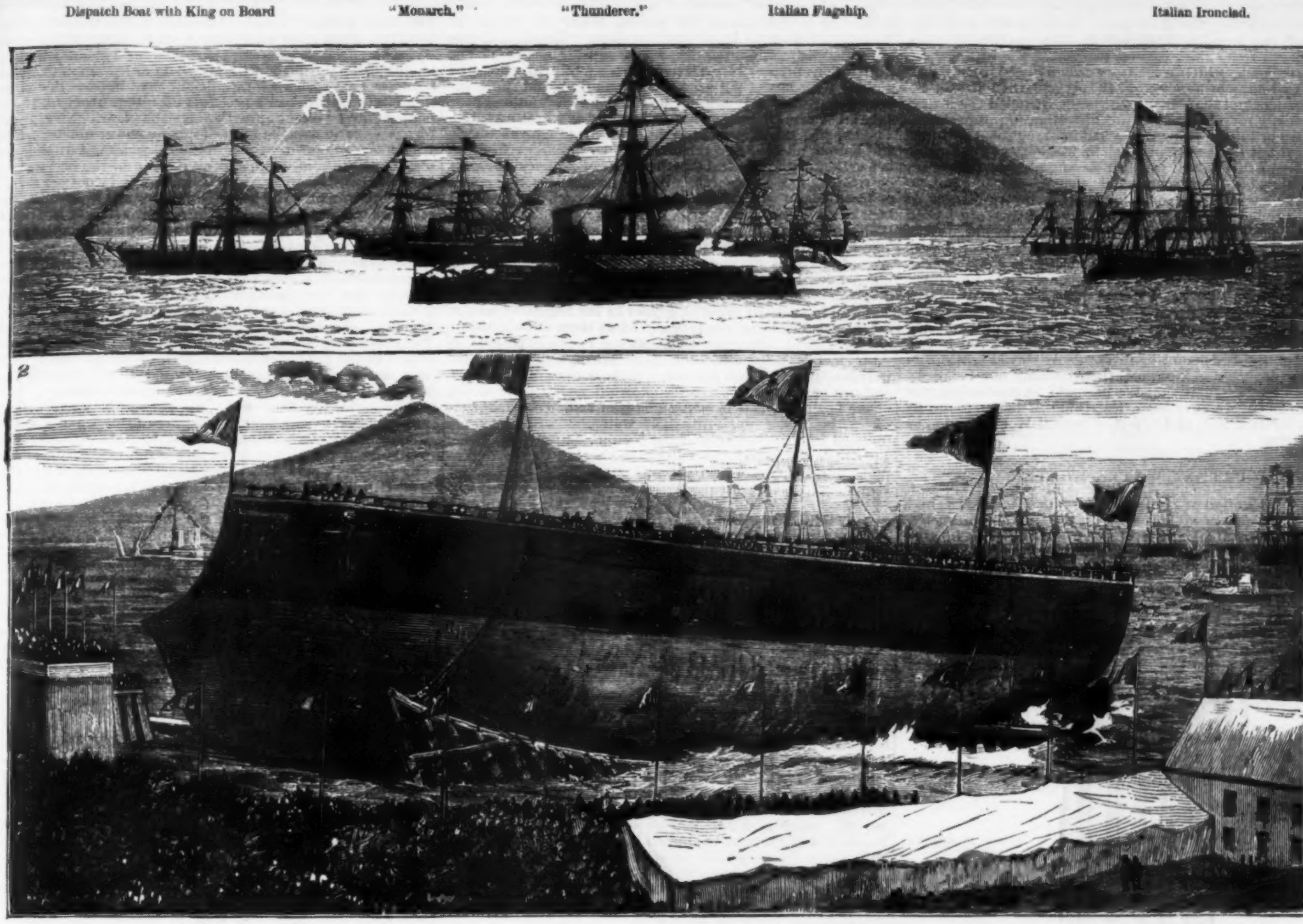


FIG. 4

In the construction of the instrument the principal thing to be attained was a frictionless parallel motion for very small distances, and this has been successfully accomplished by connecting two small frames, *k k* (see diagrams annexed), with each other by four flat springs, *d d*, of equal length. Each frame carries a hardened steel pin, *c c*, on a projecting arm. To these frames are respectively fixed a glass prism, *b*, and a black glass, *a*; the latter being adjustable can be set parallel to one side of the prism. To exclude daylight during an observation, a small brass box, *e*, open underneath, surrounds the instrument, and when the indicator is held against a bar to be strained two spiral springs, *f f*, fixed above the steel pins, *c c*, press these latter gently and steadily on to the bar. There are two other flat springs, not shown, which hold the instrument in its place, when not in use, but come out of play as soon as the box is pressed against any hard substance. A microscope, *g*, placed directly above the glass prism, enables the observer to note the relative position of a mark on the black glass with the rings, which are produced by the homogeneous light of the spirit lamp, *h*, thrown by the oblique perforated mirror, *i*, and the hypothenuse of the glass prism on to the black glass. The lamp is protected from winds and rain by a casing, and can be turned so that it remains vertical for any position of the instrument.

To make an observation, for instance, of the strains in some part of a ship while it is leaving the launching ways, the open side of the box, and with it two pins, *c c*, are pressed against a plate stringer or frame of the ship. If during the launch that particular plate or bar be strained, the rings will be seen to move. Should 30 of them have vanished and 20 have afterwards reappeared, which can easily be ascertained by counting them as they pass the mark cut into the black glass for that purpose, this would represent, first an elongation of $\frac{30}{85000}$ inch, and then a contraction of $\frac{20}{85000}$ inch in 2⅜ inches, this being the distance between the two pins, and there being about 85,000 yellow

* It is not generally known that the interference of homogeneous light is visible when the two surfaces are not in contact. Using sodium light, which is best produced by burning an equal mixture of methylated spirits and alcohol in an ordinary spirit lamp, the rings can still be seen when the surfaces are about ⅛ inch apart. The lengths of the two sodium light waves are 0·0005890 and 0·0005896 millimeter.



1. The Italian and British Fleets escorting King Humbert on his return to Naples from Castellamare.—2. The Launch at Castellamare.

LAUNCH OF THE NEW ITALIAN IRONCLAD ITALIA.

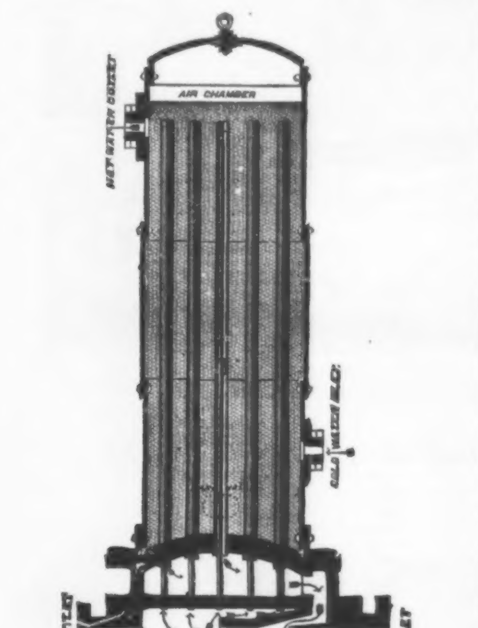
LAUNCH OF THE NEW ITALIAN IRONCLAD ITALIA.

light half wave lengths in an inch. If the modulus of elasticity of the iron is 24,000,000 lb., that particular plate would have been subjected to a tension strain of 2,900 lb. per square inch, which was afterwards reduced to 970 lb., each ring representing about 97 lb. per square inch.*

We understand that Mr. Stromeyer constructed the instrument chiefly for tre purpose of investigating the strains which occur in iron ships at sea and in exceptional positions ashore, and if he should be able to make any experiments on strains of this nature we shall be most happy to publish the results; but a more general use, in our opinion, to which the instrument can be put is the determination of strains produced in bridges, etc., when loads are passed over them. Thus applied, the instrument would form a simple and sure check on all calculations connected with the structure. Mr. Stromeyer has already had an opportunity of applying the instrument to a boiler while under hydraulic test at the works of Messrs. Fraser & Fraser, at Bow. The results were interesting and showed the inequality of strain in the shell due to the influence of the ends and the position of the riveted joints. By the aid of the instrument also the strains on some irregularly stayed portions of the structure were ascertained, these strains not being determinable by calculation. We may add, in conclusion, that the instrument we have been describing is being made by Messrs. Swift & Son, of University Street, W.C., London.—*Engineering.*

PATENT WATER HEATER.

THE introduction of the feed water into a boiler at as high a temperature as possible is a matter of much importance to the safe and economical use of steam power, both in view of maintaining an even temperature throughout the boiler, and so reducing the wear and tear arising from unequal ex-



IMPROVED WATER HEATER.

pansion and contraction, and also of effecting a direct saving in fuel, where the water is warmed by the exhaust steam or waste gases. Many forms of feed heating apparatus have been devised, and some of them largely adopted with proved advantage. A common, and under certain conditions an effective plan of heating, is to carry the exhaust pipe into an open or closed tank containing the feed water, upon the surface of which the current of steam is directed. When, however, much grease is used in the cylinder, and the water contains much carbonate of lime or magnesia, the presence of these salts in combination with the grease results in deposits on the flues and plates, and occasions leaky joints, fractured rivet holes and bulged plates, and other effects of overheating.

The accompanying engravings represent an improved water heater in which this danger is averted, while certain of the disadvantages of many surface heaters are also overcome. It is introduced by Messrs. Millar & Durie, of Manchester, and has been styled by them "the patent nozzle unlimited expansion tubular water and air heater." The illustrations present respectively a cross sectional view and a plan of the heater with the casing removed, and show the arrangement of the nozzle for producing a circulation of the exhaust steam through the circulating and heating tubes. The exhaust steam has a straight course through the nozzle and bottom chamber, so that, as will be apparent from an inspection of the illustration, there can be no back pressure on the piston of the engine. While, from the arrangement of the tubes, it will also be seen that the exhaust steam is kept entirely from the feed water, thus preventing the deposits on the flues, with the results we have referred to. The tubes are all made of solid drawn brass or copper, they are only fixed at one end, and are free to expand or contract independently of each other, so that the leakages which are common where both ends of the tubes are fixed are avoided. The employment of brass or copper in the improved heater, as the material for the tubes, renders them self-cleansing; no scurf will adhere to them, owing to the expansion of those metals being different from that of scurf. The impurities, therefore, are deposited at the bottom of the heater, and can be ejected through the blow-off cock. The casing of the heater is made of boiler plates of sufficient strength to resist the boiler pressure. The water, as will be seen, is pumped into the heater near the bottom, and Messrs. Millar and Durie claim that, the water being heated to the boiling point under pressure before it gets out at the top, a saving is effected, varying according to circumstances from 15 to 25 per cent. As will readily be perceived, this apparatus is equally suitable for heating any liquor in large quantities, and is applicable to the requirements of chemical works, baths, breweries, wool washing, and dye works, etc., as also for heating air for drying purposes, or for warming buildings. As to the excellence of the materials used, and the quality of the workmanship in these improved heaters, nothing further need be said than that the makers are Messrs. Robey & Co., of Lincoln.—*Colliery Guardian.*

* In the present instrument the pins can be shifted as close together as half an inch, and then each ring would represent about half a ton instead of 97 lb., but if necessary they can be separated, say, to 25 inch, each ring then representing only 10 lb. per square inch.

ON A NEW METHOD OF AERIAL LOCOMOTION.

WITHOUT denying altogether the possibility of directing balloons, it must be admitted that all the great amount of human ingenuity applied for solving that problem has thus far given but very little practical result.

If we turn from this method of "floating" to that of "flying," by which the elevating as well as the propelling force had to be obtained by means of wings or propellers driven by manual or steam power, we will find that here too the result is hardly a positive one, as up to this day the weight of the motors applied has always been found to be too great in proportion to their motive force. Now, although it is very probable that in course of time this proportion of weight to power will greatly be altered in favor of the latter, still for the present no practical solution of that difficulty has been suggested.

But is there, besides the two already mentioned methods, no third one, by which we could overcome the attraction of the earth?

Our answer is, Yes, there is a third method, based on a well known principle, which, however, up to this time has not been given due attention by inventors, and we may almost say, by scientific men, as in several books on natural science and mechanics, I hardly found any allusion to the following phenomena.

Let us suppose a hollow cylinder to contain gas under a high pressure: the moment we allow the gas to rush out one end, the cylinder will be pushed in the opposite direction by a force which will be proportional to the pressure of the gas and to the size of the opening. It is evident, however, that by the same cylinder we do not gain anything in effect by enlarging the opening, as by such a process we only augment the intensity of the force at the expense of its duration.

But if we succeeded in maintaining the inner pressure for a longer time without diminishing too much the size of the opening, we would obtain a continuously acting force which we might try as a motive power.

Now, the above condition can actually be realized for a certain length of time by filling the cylinder with a mixture of such solid bodies as, by being set fire to, will develop gases just as rapidly as these can flow out by the opening.

This is the way the motive force is obtained which drives the fire rocket with such astonishing velocity high into the air; and it is strange indeed that more attention has not yet been given to this kind of propulsive power, when the great number of failures already in the two over and over beaten tracks, ought to have forced aeronautical inventors to try in a new direction. Without entering too far into the failures that tried to frighten me out of these researches, I will relate briefly those only of the experiments that I think conclusive in this matter.

An iron tube 6 inches long by 1¾ interior diameter was fastened to a kind of suspended carriage, which by means of two wheels (one placed behind the other) could run easily on a wire stretched between two trees at the distance of 35 yards. One end of the tube was closed, the other had a thread for a screw cut over it, so that by means of a set of iron caps (having each one a different sized hole in its center) the opening could be reduced to 8, 6, 4, 3, 2, or 1 millimeter. The tube was filled with a composition as used for fire rockets. First, no cap was screwed on, and the 150 grammes, taking about 14 seconds to burn out, had not been able to move the carriage weighing 2 kilogrammes. Next the 8 millimeter opening was employed. The result was only a total advance of about 6 yards by short, irregular jerks. The 6 millimeter cap had a far better result, as the carriage, beginning with a slow motion, traversed the entire distance in about 11 seconds, *i. e.*, before the charge was burnt out.

With the 4 millimeters the distance traversed at the end of the first second was over 1 meter, or very nearly equal to the effect produced by a well made fire rocket which burned about the same quality of powder per second; and the entire distance was run in seven seconds. With the 3 millimeter opening the carriage was, in less than five seconds, dashed with such force against the second tree that the wheels broke down. After remedying the accident, I expected from the 2 millimeter a much more brilliant success, but was entirely disappointed, as the carriage, although started with a high velocity, suddenly came to a standstill at the middle of the distance. On examining the tube I found the marks that gas had escaped between the tube and the cap, and as this escape took place in a direction contrary to that originally intended, it explained the standstill. This opinion was corroborated by lighting the 1 millimeter; as here the carriage, hardly it began to move, was hurled back again to the point of starting.

I intended (then in Paris) to continue these experiments, but previous engagements obliged me to leave for South America, where I could do nothing in this matter. Now, however, when after some years I again came to this country, where new ideas are not regarded with such distrust as in the Old World, I will try to take up again these researches, as it seems very probable that, besides the scientific interest, there can a practical result be reached, if this matter only be taken up with sufficient vigor. Now, in my former experiments the most of motive power obtained from 1 gramme composition was to impart to a mass of 75 grammes a velocity of 12 meters at the end of the first second; in other words, by burning 1 gramme of fuel per second we could overcome the weight of 75 grammes, and give that mass an additional velocity of over 2 meters at the end of the first second. But as the cylinders I was experimenting with could not have resisted more than 25 atmospheres, and as the velocity of gases issuing under 250 atmospheres must be considerably higher than the one that gave this result, it follows that the quantity of motive force obtained can be greatly augmented by employing cylinders of a greater resistance. To what limit the pressure, and consequent useful effect, can be brought advantageously, *this* must be the object of the next experiments, and this is the point which will decide whether this invention has to obtain a practical application or will only remain a scientific curiosity.

The objection that what we gained in effect by higher pressures we would have to lose by the necessarily greater weight of the more resisting cylinders: this objection only would hold good in case we imitated the construction of a fire rocket, where a cylinder capable of resisting the intended pressure holds all the fuel that is to be burnt during the entire traject.

The remedy is obvious. Far more serious objection to this kind of motors will be found in the price of the work, but I leave this question, as it would be impossible to discuss it before conclusive experiments shall not be made.

It is, however, to be supposed that even by an extremely high price it would find several applications, being able to fulfill several conditions not otherwise to be realized, among whom not the least curious is the circumstance that such a motor could do work even if placed above the atmosphere. CHARLES SARKADY.

New York, November, 1880.

ATLANTIC CABLES.

WHEN the first Atlantic cable was laid in 1858, each step in the operations was carefully reported in the daily press, and eagerly perused, owing to the novelty of the work and the intense interest it had aroused in the public mind. In the same way, though perhaps to a less extent, the operations of 1865 and 1866 were made public. In 1859 the cable laid between Brest and St. Pierre, known for some time as the French Atlantic, caused less interest. The cables of 1873 and 1874 were but briefly recorded, and the cables laid last year and this year have scarcely been noticed at all. This is partly due to the rivalry existing between the two telegraph companies, as well as between the firms who have made and laid the cables. Very little information is to be obtained on the subject from the principal persons concerned in the work, who, it would appear, wish to have as little made public as possible for fear of their adversaries gaining some advantage by it. This appears to us excessively childish, for any persons having sufficient interest in gaining particulars of either work, to be willing to incur a small expense and trouble, might easily obtain all the information be desired concerning the cables and operations. The rival parties themselves are not likely, therefore, to have any difficulty in knowing all that occurs in the enemy's camp, and it is only the public, and those who take an interest in the subject generally from a technical and scientific point of view, who are deprived of the information as to what is being done in this branch of engineering. There may be some slight advantage to contractors in thus keeping all experience and information as much as possible to themselves, but we doubt very much whether this exclusion of all, except those who are actually employed on the work, from any information as to the progress that is being made, is beneficial or will tend toward the advancement of telegraphic engineering generally. Improvements and new ideas do not always come from rich, conservative, and exclusive bodies or corporations, and unless what may be termed outsiders hear a little of what is on, it is unlikely that they will turn their attention to improvements.

That an improvement on the type of cable employed on the Atlantic in 1865 and 1866, and which is known among engineers as "Atlantic type," is required is proved by the fact that these cables had only lives of about 8½ years, and if cables will only last that time, even 10 per cent. dividends will not pay for them, whereas most cables at present only pay about 6 or 7 per cent.

The type we allude to consists in ten homogeneous iron wires, each separately surrounded with strands of Manila hemp, as the mechanical structure round the jute-covered core. This type of cable when new is, of course, excellent for the process of laying. It has a low specific gravity and great friction from the roughness of the Manila hemp, and can consequently be laid with a given amount of slack with a very small strain during the operation of paying out. But as regard its durability it has little to recommend it. The wires being separated allow insects easily to enter. The hemp rots and the iron rusts away. The 1873 and 1874 cables had a little hemp and pitch and silica laid on round the whole, and have thus an additional protection, but the coating was meager.

The cable laid by Messrs. Siemens last year, we believe, consists of homogeneous iron wires touching one another, thus returning to what has been known as the Mediterranean type of cable, the iron being protected from rust by two coatings of yarn, pitch, and silica round the whole cable.

The cable laid this year by the Telegraph Construction Company has ten homogeneous iron wires, each covered with a thick coating of preservative compound called Clifford's compound, the composition of which is kept secret, and these are each separately further covered with tape. Between each wire a strand of hemp is placed. The whole cable thus formed has two layers of tape and pitch compound outside all. The mode of combining hemp and iron alternately round the core has been before largely adopted by the Telegraph Construction Company, and was first, we believe, employed on the cable between Sydney and New Zealand. We do not know what advantages are claimed for this plan, but it would appear to us to be principally a mode of saving first cost by substituting hemp for iron at the expense of durability. It does not seem possible that the hemp can take any strain properly with the iron, and when the cable gets old, we should think the hemp would not keep the wires in place when the cable is being strained or bent about in repairs so well as hemp round each wire. It is cheap, and that is all that can be said for it. The strong

outer coating of tape and pitch no doubt keeps the wires in place when the cable is new, but we should look to what will be the state of the cable when this outside coating of hemp is gone. When the hemp has perished considerably it seems clear that the wires, with wide spaces between them like a bird cage, will not in the least fulfill the conditions of a wire rope, and we shall be very much astonished if after a few years of experience at repairing, this type of cable, with alternate wire and hemp, is not abandoned as a mistake. The attempt to preserve each wire with a compound, whatever it may be, is a step in the right direction. Gutta percha applied in the ordinary way round wires for protection was proposed and patented by Mr. Samuel Statham in 1857. We do not know what Clifford's compound is, but we doubt whether it is better than gutta percha, though perhaps much cheaper.

As regards the process of paying out there was one novelty in the Siemens expedition which we will describe. It is necessary, in order to distribute the slack of a cable uniformly or in such places as the engineer may decide on, to know at every half hour the exact position of the ship over the ground. To do this by observations even in fine weather is only possible once every twenty-four hours, and when the sky is overcast not even then. Dead reckoning is not to be trusted on account of currents. The following plan was adopted therefore, and forms one of the latest novelties in cable laying: a steel pianoforte wire was paid out throughout all the deep water passage with sufficient tension to insure its being laid without any slack, and thus the distance actually run was measured and known at every minute. The wire was, we believe, in 50 mile lengths on drums, and the lengths were rapidly joined by a hook joint.

In paying out the Anglo-American cable this year two ships were employed, the Scotia and Seine, and when the Scotia had nearly finished paying out her length, the cable was made fast to a buoy at some fathoms from the end, the stray quantity being coiled into a lifeboat, and the end thus handed to the bows of the Seine. We believe that in laying the Siemens cable last year there was a similar change from the Faraday to the Pouyer-Quertier.

It seems a pity that these operations are not published in detail, as they both no doubt reflect credit on those who have conducted them, and would be of great interest to all who follow up the important question of Atlantic telegraphy.

The laying of the Siemens cable, we believe, was under the superintendence of Mr. Loeffler, assisted by Mr. Brittle, Mr. Jacobs being the chief electrician. The cable laid this year by the Telegraph Construction Company was under the charge of Captain Halpin, assisted by Mr. Loudon, Mr. Laws being the chief electrician. Captains Cato and Manning commanded the two ships.—*Engineering.*

SEWAGE DISPOSAL.*

By JAMES CRAGGS.

In this paper the author proposes to give a brief outline of the scheme of sewerage and sewer disposal which he designed and has nearly completed for the Shildon and East Thickly Local Government District. With a view to enable the members of the association to follow his description, he has arranged the subject under the following heads: Main Drain—Subsiding Tank—Surface Preparation.

I. MAIN DRAIN.—The sewage of this district is conveyed by an egg-shaped brick sewer 2 feet 3 inches by 3 feet 3 inches, built of 9 inch common brickwork, the inner rim being laid in cement, and the outer in lime mortar. It has a gradient of about 1 in 400, which fall, in the author's opinion, is ample in all cases where any part of the district to be drained is considerably above the main sewer; the length of the main sewer is nearly a mile, and the contract price was somewhat below the estimated cost of £1,800, including the cost of constructing sixteen manholes. The population of the district is 10,000, but sufficient capacity has been provided in the outfall drain for 50,000. This will be plainly seen when it is stated that only sewage is allowed to enter these drains, provision being made for rainfall and surface water by a separate set of drains, which are exclusively used for this purpose.

II. SUBSIDING TANKS.—There are two subsiding tanks, each 150 feet in length, 9 feet wide, and 6 feet deep, built of 9 inch common brickwork in lime mortar, the sides having 3 inch batter upon them. The tanks are 12 feet apart, with a paved cartway between them; the bottom of each tank is paved with bricks flat, and through each a drain is built, 1 foot 6 inches square, of 4½ inch brickwork, with every third half brick left out. The top of the drain is covered with 2 inch flags, dry and rough jointed; these drains are upon the same level as the upper carrier, for the purpose of securing an even flow of the sewage. Across each tank is built a 9 inch brick wall, several bricks being left out to allow the sewage to pass through. The wall has also to some extent a tendency to prevent the sewage flowing too quickly, a result which, in the author's opinion, is very necessary, because the stiffer the sewage is kept the greater the amount of sludge retained. The tanks are filled in in the following manner: 1 foot 2 inches of bowlder stones, not larger than 10 inch cube, and diminishing in the size of fine gravel free from sand; over this is placed a covering of 4 inches of fine coke ballast. This upper layer will be required to be removed twice a year, and will form manure of a good quality, which should realize a good price per load.

III. UNDER DRAINAGE.—The under drains are principally laid with 4 inch common tiles, and when the leveling, etc., is completed, they will be on an average about 6 feet deep. Two 6 inch, one 9 inch, and one 12 inch mains are laid with a final outlet main, laid with 15 inch pipes. The pipe joints are covered with a flat shaving, properly packed at each side with clay. After the joints have been made in the manner described, a slight covering of soil is then put on, after which a covering of small stones is laid 6 inches deep, and upon these is placed a covering of puddled clay 6 inches deep, properly beaten down, for the purpose of preventing the sewage from entering direct into the drains before being purified.

IV. SURFACE PREPARATION.—The twenty acres of land used for sewage disposal are divided into four parts, arranged upon three different levels, each plot having a gradient of 1 in 400. A properly puddled embankment is made round the whole of the land 1 foot 3 inches above the surface, to prevent the sewage saturating the adjoining fields. The four plots contain about five acres each, less embankments and roads. The sewage is conveyed from the tanks on to the high plots in a 12-inch carrier, from which it is let out on to the land by Craggs' junction blocks built into small cesspools, and thereby dispersed over the whole or any portion of the five acres by a trench plowed parallel to the carriers. In the case of the low carrier, the sewage is conveyed by a 12-inch drain from the tanks to a manhole, constructed to resist the pressure of the sewage, where it finds its own level, and falls into a cesspool upon the same level as the carrier. In this cesspool the sewage subsides, and flows steadily and evenly into the carrier. A cart road, 15 feet wide, will be made from east to west through the fields, with proper approaches from each plot, in order to facilitate the removal of the produce. In conclusion, the author will only add that he trusts the members will freely discuss and criticise the general arrangement of the scheme and the details of the work as executed.

* Read at the meeting of the Association of Municipal and Sanitary Engineers and Surveyors held at Darlington on the 24th September, 1880.

SAGAR'S IMPROVED TAKING-UP MOTION.

WE have heard a great deal during the past few years of improvements in "letting-off motions," but the opposite part, the "taking-up motion," has to a great extent been neglected, though perhaps radically the most defective part of the loom.

As ordinarily used, this is a series of wheels actuated from the slay sword, which usually—at least in the East Lancashire district—consists of the following:

Driven Wheels.	Driver Wheels.
Rack wheel, 50 teeth..	Pinion on double wheel, 15 teeth.
Stud " 120 " ..	Circumference of beam, 15×4, 60.
Beam " 75 " ..	Change wheel, — teeth.

Out of these figures, or a similar series, what is known as the "dividend" is obtained, by multiplying the driven wheels into each other, the drivers in the same way, and dividing the former by the latter, the quotient being the dividend sought, thus:

$$\frac{50 \times 120 \times 75}{15 \times 60} = 500.$$

This is the theoretical dividend of the Blackburn loom, but it is not used in this form, because it is found in practice that when the cloth has the tension necessary for weaving taken from it, there is an appreciable contraction which affects the result; that is, cloth on the table counts more than when in the loom. To counteract this it is usual to take the dividend, plus 1½ per cent.; hence the 500 given becomes 507, the fraction being disregarded.

Suppose a cloth is wanted of any given number of picks; on this principle it can rarely be made with exactitude. As long as the cloth required has not to contain more than 10 to 15 picks, a fair approximate can be made, though accuracy is not possible; but when the requirement exceeds these figures the divergence becomes serious, and entails the necessity of giving something important, more or less, than is stipulated for. To do the former, neither sound principles of business nor the severity of competition will permit, while to give less subjects the producer to endless risks in the fluctuations of the market. Should the latter go against the merchant, it is a very common practice with him to seek an excuse for shifting the burden of loss to the shoulders of the manufacturer. In this case he has not far to seek—there is always one ready for him, and it is often availed of. Conscientious manufacturers sometimes decline orders of this kind, or hand them over to friends whose "dividend" will allow them to be made with less risk or loss.

The following examples will show the inaccuracies resulting from the above system with the 507 dividend; other numbers are no better:

A 15 wheel yields			33·8	picks.
16	"	"	31·687	"
17	"	"	29·235	"
18	"	"	28·166	"
19	"	"	26·684	"
20	"	"	25·35	"
21	"	"	24·143	"
22	"	"	23·045	"
23	"	"	22·043	"
24	"	"	21·125	"

In many instances where old looms with low dividends are still in use, the results are much worse than these. In some districts, where heavily picked cloths are made, Chorley for instance, a higher dividend is obtained by substituting a rack wheel of 80 teeth, which, with the other particulars of the Blackburn gearing, gives 609, but this change involves a great amount of trouble.

With this system, however, irregularity, confusion, and loss are unavoidable; and only the fact that no better has been available has made it endurable. We are glad, however, to have the opportunity of bringing before our practical readers a plan whereby perfect accuracy is obtained, and loss incident to all forms of the old system is avoided.

In this invention five wheels, as in the dividend system, are used, the alteration being made in the stud wheel. Instead of using the ordinary large wheel of 120 or other number of teeth, Mr. Thomas Sagar, of Burnley, Eng., the inventor, substitutes the change wheel, which thus becomes a driven wheel, instead of, as before, a driver. This necessitates the provision of a fixed pinion on the ratchet wheel axle. The number of teeth this shall contain is decided by the number of parts into which it is desired to divide the pick: halves, quarters, thirds, eighths, or sixteenths. Suppose quarters be taken, then 4 teeth equal 1 pick. The number of these parts multiplied by six give the number of teeth in the ratchet pinion, which takes the place of the change wheel in the old system. The train of gearing will now stand thus:

Driven Wheels.	Drivers.
Ratchet wheel, 58 teeth..	Ratchet pinion, 24 teeth.
Change wh'l as required.	Change wheel pinion, 15 "
Beam wheel, 90 teeth ...	Circumference of beam in quarter inches, 58 "

Suppose a 10-pick cloth be wanted, 4 teeth being required for 1 pick $10 \times 4 = 40$, the change wheel required. In another form it is shown thus:

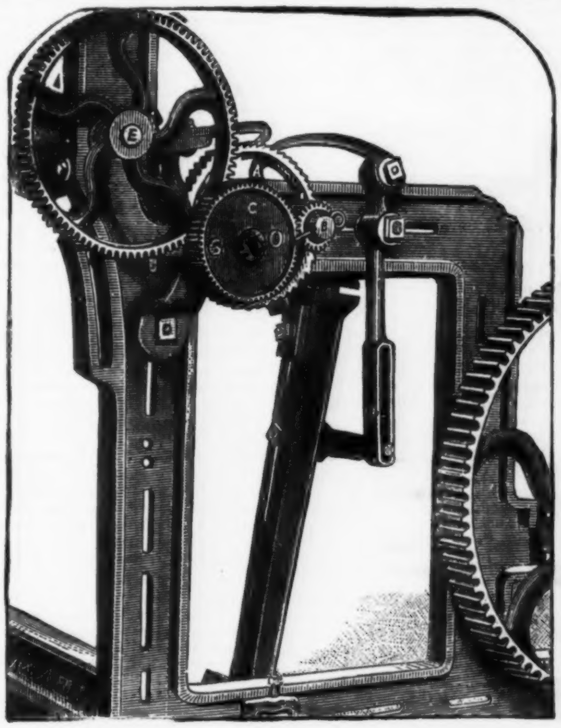
$$\frac{58 \times 40 \times 90 = 3{,}600}{24 \times 15 \times 58 = 360} = 10.$$

The dividend is thus practically dispensed with, and any fraction of a pick is obtained with facility and perfect accuracy, accordingly as the use of one or other rack wheel pinion may have been decided upon. Halves require a 12 wheel; thirds, one of 18; fourths, as shown, a 24; fifths, a 30; sixths, 36, etc., etc.

It will be obvious to every one practically acquainted with manufacturing that this improvement is one of great importance, and will enable cloth to be made with more exactitude and economy than ever before.

The accompanying illustration is introduced to show that the invention scarcely induces a visible alteration in the present arrangement of the taking-up gear. The rack wheel, A, occupies its usual place, but, instead of the change wheel, carries on its axle a permanent pinion, B, which gears into the change wheel, C, which has taken the place of the stud wheel. Behind the change wheel the stud pinion remains as before, gearing into the beam wheel, E, fixed on the axle of F, the taking-up roller.

In order that the merits of this improvement, which can easily be applied to existing looms, may be fully appreciated, let our practical readers sit down and make a calculation of the economy which would result in twelve months from its adoption in a shed of 500 or 800 looms, as compared with the use of the present system. They will need no other argument to convince them of its merits.—*Textile Manufacturer.*



IMPROVED TAKE-UP MOTION.

IT is stated that the Bank of France has almost entirely abandoned chemical tests in favor of the camera for detecting forgeries. The sensitive plate not only proclaims forthwith the doings of the eraser or penknife, but frequently shows, under the bold figures of the forger, the sum originally borne by the check. So quick is the camera to detect ink marks that a *carte-de-visite* inclosed in a letter may to the eye appear without blemish, while a copy of it in the camera will, in all likelihood, exhibit traces of writing across the face, where it has merely been in contact with the ink.

AT the annual meeting of the Tehuantepec Railroad Company, held at Pittsfield, Mass., October 20, the following gentlemen were elected directors: Edward Learned, of Pittsfield; T. J. Buckley, George S. Coe, Cortland P. Dixon, Ozias Bailey, Myron P. Bush, John A. Marvin, Hayden H. Hall, W. P. Learned, all of New York; and Manuel Gamboa and Francisco de Harrando, of Mexico. The reports were very flattering, thirty miles of the road being already graded, and the track laid for about ten miles.

VARIOUS TOOLS.

Mallets.—We here present three styles of mallets, such as used in France, Germany, and this country. Fig. 1 represents the French mallet, used in Paris body shops. It is unsightly and heavy, but the French body maker handles it with great ease in making mortises or securing the holdfast. Fig. 2 is the German mallet, which has a better finish

FIG. 1. FIG. 2. FIG. 3.

and better made than Fig. 1, but not so effective in concentrating the stroke. Fig. 3 is the mallet used in this country. It is smaller than the preceding, and has a better shape and handier. An American body maker has little use for a heavy mallet, as his fine and improved tools give him greater facilities for doing more work with less manual force.

Long Clamps Made of Broken Hand Screws.—Long clamps are usually made of iron, and are very useful in screwing pieces or heavy bodies together when set up. They are

FIG. 1.

always wanted in the body shop. A body maker can well use five or six in gluing the upper back panel on an English coach, and still use more if he had them.

A good substitute for them when more are wanted and not forthcoming, is old screws, which, if not too short, can be utilized to make first-class long clamps. Suppose Fig. 1 is the broken clamp. Nearly all break at that point. Drill

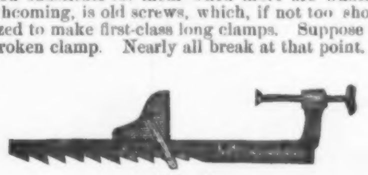


FIG. 2.

two holes in it as marked; cut a piece of hickory 2 by 1½ inches, as Fig. 2, and fasten on to Fig. 1, as shown, with two bolts. This gives a long clamp.

Tools for Scroll Makers.—Since we published our supplement of scrolls which appeared with the November number of last year, much interest has been manifested in making them, and the inquiries have been general as to how to carve these and what tools are used. To make these scrolls, one

FIG. 1.

must have the proper tools and know how to use them. Fig. 1 shows ten different shapes, all adapted to carving scrolls of every description; also nine shapes of gouges which are indispensable in doing good and quick work.—*Carriage Monthly.*

PHOTO-LITHOGRAPHIC PRINTING.

THREE months ago we pointed out, in these columns, certain improvements which had recently been made in the Government map-printing establishment at Vienna, where the ordnance maps are all produced by photo-lithography, the most important of all being the use of a velvet roller for the purpose of inking up the bichromate print and converting it into a transfer. This last innovation has now been made in the photo-lithographic establishment which Mr. Butter organized some years ago at Woolwich, and which produces work equal to any in the kingdom, if not in the world. The process seemed to us so beautiful and, at the same time, so simple, that we feel sure the readers of this journal will be willing to listen to an account of our visit.

Mr. Butter has so recently given a succinct account of the ordinary routine of the establishment, that we need not refer again to the older method of working; but we must first say a word about the taking of the negative. Here is the studio—a lofty glass house—in which the negatives are secured, and running down the middle of it is a little tramway. The rails are some twenty inches apart, and upon them run the casters of a heavy oblong table; the table carries the camera, which is in this way advanced or retired without difficulty, a few simple wedges fixing the casters as soon as the necessary focus has been obtained. Under ordinary circumstances a spirit level would be necessary to see if the camera is truly horizontal, and a plumb line to ascertain if the drawing board, upon which the plan to be copied is stretched, is quite perpendicular; but with the assistance of suitable fixtures such testing is no longer necessary. The camera table as it runs along the rails is known to be properly adjusted, and the solid board fixed upright at right angles to the tramway is always in position. This upright board is covered with a sheet of white paper, in the middle of which is a tiny cross that marks the center or axis of the lens.

Here is a drawing ready for copying; it is on tracing-paper, and we remark at once upon its grayish tint. "Is the ground white enough to give an opaque film?" we ask. "When it is backed with white cartridge paper it will be," is the reply; and having first provided it with this backing, the tracing paper is fixed by means of drawing pins before the camera. The sheet measures three feet, and the photo-lithograph is to be twelve inches. There are fine lines and broad ones, dotted lines and delicate curves, but they seem to give no difficulty. The focus is taken midway between center and margin of the picture; the lens, by the bye, being a rectilinear of twenty-six inches equivalent focus. A short exposure is given, and the delicate gray image, with its transparent lines, is then treated with Eder's lead intensifier, which is described in Mr. Butter's paper, and which renders the ground of the negative as "black as your hat."

We are now taken in hand by Mr. Baker, the chief draughtsman of the establishment, under whose immediate charge the work of photo-lithography is conducted. "We have come to see the velvet roller process," we tell Mr. Baker. "It is so promising that it bids fair to oust the older process altogether," is his reply; and in confirmation of his opinion he exhibits a series of prints that have been pulled from the stone from a transfer just made.

The sensitizing room is a small apartment with one large window, of which the lower half is darkened by a shutter, and the upper hung with tammy. Here the paper is sensitized. Only bank post is employed, a very tough and smooth material. "There are two kinds of bank post," says Mr. Baker; "one having parallel lines running across the sheet, and this is of no use whatever in the process." The paper is floated upon the bichromate and gelatine mixture—one coating is usually sufficient, if it is skillfully done—and, when dry, exposed under the negative in the shade. Five minutes' printing is ample in the summer time, if the lines of the negative are pure and clear; but the time can only be well judged by an experienced printer. When looked at in the dark room, the faint brown marking of the image on the yellow paper is scarcely perceptible, and for this reason it is well to mark the face of the paper with a black lead pencil immediately before sensitizing.

We have now before us a bichromated-gelatine print, and we are going to treat it by the velvet roller process. It is handled very much like carbon tissue that has just been printed. Mr. Baker throws it into cold water and allows it to remain immersed for four or five minutes. He now takes a glass plate, rather shorter than the print, so that the ends may tuck under, and puts the impression carefully on the glass surface. The operations may henceforth be conducted in the light, for as soon as the print goes into cold water, you need be under no apprehension of spoiling it by daylight. The wet print is squeegeed upon the glass plate, and the superfluous moisture further removed by lightly laying upon the surface a sheet of bibulous paper. "Let the print be too wet rather than too dry," says our friend the chief draughtsman, as he carries it off to the lithographic room.

Here some ordinary re-transfer ink has been considerably thinned with turpentine, and well rolled upon a slab with an ordinary leather roller. A burnished steel plate, close at hand, is now coated with a fine even surface of the dilute transfer ink by the application of the same roller, and then the velvet roller is taken in hand. This is passed over the steel plate to take up the ink, and then delicately rolled over the bichromate print. The ends of the print being double under the glass plate, it is kept flat and firm, and, to allow the lithographer sufficient play for his hands, the slab on which the glass plate rests is no larger than necessary for the purposes of support. At first the velvet roller is passed lightly over the surface, but some weight is afterward borne upon it. "You see, I treat the paper print precisely as I would a stone," said the skillful lithographer, and he certainly did. The bicarbonate print was sponged and rubbed, and rolled and watered, just as if it were a lithographic stone, and in a few minutes the blank sheet of paper, which at first bore but the faintest of brown markings, was covered with fine black lines of the most exquisite sharpness—a design in miniature of the original drawing. Continued rolling up—carried out, be it remembered, by a skilled lithographer—brought more of the viscid black ink upon the lines, and in a quarter of an hour (for very little cleaning was necessary) the plan was ready for transferring to stone. When wetting the paper is undesirable, breathing upon it will often impart sufficient moisture to the film to enable it to repel the ink from the roller. Before applying the finished transfer to a warm lithographic stone, it is well washed in cold water to remove the superfluous gelatine from the surface.

"In the older process, you will remember," said Mr. Baker, "the inking up had to be done in the dark, and there was the necessity for a supply of warm water, maintained at an even temperature." The chief draughtsman added that the lines produced by the velvet roller seemed to him both finer and less given to rottenness, while the process took up less time. The fact, too, that the lithographer could work at the simple bichromate print, as it came out of the pressure frame, as if it were a stone, was a point the importance of which could not very well be overrated. Mr. Baker has, indeed, found it possible to pull copies from the bichromate print in the lithographic press, and is sanguine about simplifying the photo-lithographic processes still further by thus employing the photographic impression on paper as a printing block instead of as a transfer.

That the collotype printer will be able to make good use of the velvet roller is but a matter of course, in manipulating the film in the first place, when very tender treatment is necessary; while we cannot help thinking that this useful appliance may open the door to photographers who are conversant with bichromate printing to practice a simple photo-lithographic or collotype process. Only some knowledge of and practical skill in lithography are, obviously, necessary.—*Photographic News.*

PROF. HUXLEY ON SCIENTIFIC EDUCATION.

AT the recent opening ceremony of Sir Josiah Mason's Science College, Birmingham, Eng., Prof. Huxley delivered an address of which the following is an abstract. Referring to the gratification which Priestley would doubtless have felt if he had lived to witness the inauguration of such an institution, Prof. Huxley said: The kindly heart would be moved, the high sense of social duty would be satisfied, by the spectacle of well-earned wealth, neither squandered in tawdry luxury and vainglorious show, nor scattered with the careless charity which blesses neither him that gives nor him that takes, but expended in the execution of a well considered plan for the aid of present and future generations of those who are willing to help themselves. We shall all be of one mind thus far. But it is needful to share Priestley's keen interest in physical science—to have learned, as he had learned, the value of scientific training in fields of inquiry apparently far remote from physical science—to appreciate, as he would have appreciated, the value of the noble gift which Sir Josiah Mason has bestowed upon the inhabitants of the Midland district.

For us children of the nineteenth century, however, the establishment of a college under the conditions of Sir Josiah Mason's trust has a significance apart from any which it could have possessed a hundred years ago. It appears to be an indication that we are reaching the crisis of the battle, or rather of the long series of battles, which have been fought over education in a campaign which began long before Priestley's time and will probably not be finished just yet. In the last century the combatants were the champions of ancient literature on the one side, and those of modern literature on the other; but some thirty years ago the contest became complicated by the appearance of a third army, ranged under the banner of physical science. I am not aware that any one has authority to speak in the name of this new host, for it must be admitted to be somewhat of a guerilla force, composed largely of irregulars, each of whom fights pretty much for his own hand.

But the impressions of a full private who has seen a good deal of service in the ranks respecting the present position of affairs and the conditions of a permanent peace may not be devoid of interest, and I do not know that I could make a better use of the present opportunity than by laying them before you. From the time that the first suggestion to introduce physical science into ordinary education was timidly whispered, until now, the advocates of scientific education have met with opposition of two kinds. On the one hand, they have been pooh-poohed by the men of business, who pride themselves on being the representatives of practicality; while, on the other hand, they have been excommunicated by the classical scholars, in their capacity of Levites in charge of the ark of culture and monopolists of liberal education. The practical men believed that the idol whom they worship—Rule of Thumb—has been the source of the past prosperity, and will suffice for the future welfare of the arts and manufactures. They were of opinion that science is speculative rubbish; that theory and practice have nothing to do with one another; and that the scientific habit of mind is an impediment, rather than an aid, in the conduct of ordinary affairs. I have used the past tense in speaking of the practical men; for, although they were very formidable thirty years ago, I am not sure that the pure species has not been extirpated. In fact, so far as mere argument goes, they have been subjected to such a *feu d'enfer* that it is a miracle if any have escaped.

But I have remarked that your typical practical man has an unexpected resemblance to one of Milton's angels. His spiritual wounds such as are inflicted by logical weapons, may be as deep as a well and as wide as a church door, but beyond shedding a few drops of ichor, celestial or otherwise, he is no whit the worse. So, if any of these opponents be left, I will not waste time in vain repetition of the demonstrative evidence of the practical value of science; but, knowing that a parable will sometimes penetrate where syllogisms fail to effect an entrance, I will offer a story for their consideration. Once upon a time, a boy, with nothing to depend upon but his own vigorous nature, was thrown into the thick of the struggle for existence in the midst of a great manufacturing population. He seems to have had a hard fight, inasmuch as by the time he was thirty years of age his total disposable funds amounted to twenty pounds. Nevertheless, middle life found him giving proof of his comprehension of the practical problems he had been roughly called upon to solve, by a career of remarkable prosperity. Finally, having reached old age with its well-earned surroundings of "honor, troops of friends," the hero of my story bethought himself of those who were making a like start in life, and how he could stretch out a helping hand to them. After long and anxious reflection, this successful, practical man of business could devise nothing better than to provide them with the means of obtaining "sound, extensive, and practical scientific knowledge." And he devoted a large part of his wealth and five years of incessant work to this end.

I need not point the moral of a tale which, as the solid and spacious fabric of the Scientific College assures us, is no fable, nor can anything which I could say intensify the force of this practical answer to practical objections. We may take it for granted then, that, in the opinion of those best qualified to judge, the diffusion of thorough scientific education is an absolutely essential condition of industrial progress, and that the college opened to-day will confer an inestimable boon upon those whose livelihood is to be gained by the practice of the arts and manufactures of the districts. The only question worth discussion is, whether the conditions under which the work of the college is to be carried out are such as to give it the best possible chance of achieving permanent success. Sir Josiah Mason, without doubt most wisely, has left very large freedom of action to the trustees to whom he proposes ultimately to commit the administration of the college, so that they may be able to adjust its arrangements in accordance with the changing conditions of the future. But, with respect to three points, he has laid most explicit injunctions upon both administrators and teachers. Party politics are forbidden to enter into the minds of either, so far as the work of the college is concerned; theology is as sternly banished from its precincts; and, finally, it is especially declared that the college shall make no provision for "mere literary instruction and education."

It does not concern me at present to dwell upon the first two injunctions any longer than may be needful to express my full conviction of their wisdom. But the third prohibition brings us face to face with those other opponents of scientific education, who are by no means in the moribund condition of the practical man, but alive, alert, and formidable. It is not impossible that we shall hear this express exclusion of "literary instruction and education" from a college which, nevertheless, professes to give a high and efficient education, sharply criticised. Certainly the time was that the Levites of culture would have sounded their trumpets against its walls as against an educational Jericho. How often have we not been told that the study of physical science is incompetent to confer culture; that it touches none of the higher problems of life; and, what is worse, that the continual devotion to scientific study tends to generate a narrow and bigoted belief in the applicability of scientific methods to the search after truth of all kinds. How frequently has one reason to observe that no reply to a troublesome argument tells so well as calling its author a "mere scientific specialist." And, as I am afraid it is not permissible to speak of this form of opposition to scientific education in the past tense, may we not expect to be told that this, not only omission, but prohibition of "mere literary instruction and education," is a patent example of scientific narrow-mindedness?

I am not acquainted with Sir Josiah Mason's reasons for the action he has taken; but if, as I apprehend in the case, he refers to the ordinary classical course of our schools and universities, by the name of "mere literary instruction and education," I venture to offer sundry reasons of my own in support of the action. For I hold very strongly by two convictions: the first is that neither the discipline nor the subject matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time upon either; and the second is that, for the purpose of obtaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education. I need hardly point out to you that these opinions, especially the latter, are diametrically opposed to those of the great majority of educated Englishmen, influenced as they are by school and university traditions. In their belief, culture is obtainable only by a liberal education; and a liberal education is synonymous, not merely with education and instruction in literature, but with one particular form of literature—namely, that of Greek and Roman antiquity. They hold that the man who has learned Latin and Greek, however little, is educated; while he who is versed in other branches of knowledge, however deeply, is a more or less respectable specialist, not admissible into the cultured caste. The stamp of the educated man, the university degree, is not for him.

I am too well acquainted with the generous catholicity of spirit, the true sympathy with scientific thought, which pervades the writings of our chief apostle of culture to identify him with these opinions; and yet one may cull from one and another of those epistles to the Philistines, which so much delight all who do not answer to that name, sentences which lend them some support. Mr. Arnold tells us that the meaning of culture is "to know the best that has been thought and said in the world." It is the criticism of life contained in literature.

Considering progress only in the "intellectual and spiritual sphere," I find myself wholly unable to admit that either nations or individuals will really advance if their common outfit draws nothing from the stores of physical science. I should say that an army without weapons of precision, and with no particular base of operations, might more hopefully enter upon a campaign of the Rhine, than a man, devoid of a knowledge of what physical science has done in the last century, upon a criticism of life. When a biologist meets with an anomaly he instinctively turns to the study of development to clear it up. The rationale of contradictory opinions may with equal confidence be sought in history. It is, happily, no new thing that Englishmen should employ their wealth in building and endowing institutions for educational purposes. But, five or six hundred years ago, deeds of foundation expressed or implied conditions as nearly as possible contrary to those which have been thought expedient by Sir Josiah Mason. That is to say, physical science was practically ignored, while a certain literary training was enjoyed as a means to the acquirement of knowledge which was essentially theological. The reason of this singular contradiction between the actions of men alike animated by a strong and disinterested desire to promote the welfare of their fellows, is easily discovered. At that time, in fact, if any one desired knowledge beyond such as could be obtained by his own observation, or by common conversation, his first necessity was to learn the Latin language, inasmuch as all the higher knowledge of the Western world was contained in works written in that language. Hence Latin grammar, with logic and rhetoric, studied through Latin, were the fundamentals of education. Theological dicta were, to the thinkers of those days, that which the axioms and definitions of Euclid are to the geometers of these. The business of the philosophers of the Middle Ages was to deduce, from the data furnished by the theologians, conclusions in accordance with ecclesiastical decrees.

The sum and substance of the whole doctrine was to produce the conviction that the only thing really worth knowing in this world was how to secure that place in a better which, under certain conditions, the Church promised. Our ancestors had a living belief in this theory of life, and acted upon it in their dealings with education, as in all other matters. Culture meant saintliness—after the fashion of the saints of those days; the education that led to it was of necessity theological; and the way to theology lay through Latin. That the study of nature—further than was requisite for the satisfaction of every-day wants—should have any bearing on human life was far from the thoughts of men thus trained. Indeed, as nature had been cursed for man's sake, it was an obvious conclusion that those who meddled with nature were likely to come into pretty close contact with Satan. And if any born scientific investigator followed his instincts, he might safely reckon upon earning the reputation, and probably upon suffering the fate, of a sorcerer.

The representatives of the Humanists, in the nineteenth century, take their stand upon classical education as the sole avenue to culture, as firmly as if we were still in the age of Renaissance. Yet surely the present intellectual relations of the modern and the ancient world are profoundly different from those which obtained three centuries ago. Leaving aside the existence of a great and characteristically modern literature, of modern painting, and, especially, of modern music, there is one feature of the present state of the civilized world which separates it more widely from the Renaissance than Renaissance was separated from the Middle Ages. This distinctive character of our own times lies in the vast and constantly increasing part which is played by natural knowledge. Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it; but our whole theory of life has long been influenced, consciously and unconsciously, by the general conceptions of the universe which have been forced upon us by physical science. In fact the most elementary acquaintance with the results of scientific investigation shows us that they offer a broad and striking contradiction to the opinions so implicitly credited and taught in the Middle Ages. The notions of the beginning and the end of the world entertained by our forefathers are no longer credible. It is very certain that the earth is not the chief body in the material universe, and that the world is not subordinated to man's use. It is even more certain that nature is the expression of a definite order, with which nothing interferes, and that the chief business of mankind is to learn that order, and govern themselves accordingly.

Moreover, this scientific "criticism of life" presents itself to us with different credentials from any other. It appeals not to authority, nor to what anybody may have thought or said, but to nature. It admits that all our interpretations of natural fact are more or less imperfect and symbolic, and bids the learner seek for truth not among words but among things. It warns us that the assertion which outstrips evidence is not only a blunder, but a crime. The purely classical education advocated by the representatives of the Humanists in our day gives no inkling of all this. A man may be a better scholar than Erasmus, and know no more of the chief causes of the present intellectual fermentation than Erasmus did. Scholarly and pious persons, worthy of all respect, favor us with allocutions upon the sadness of the antagonism of science to their mediæval way of thinking, which betray an ignorance of the first principles of scientific investigation, an incapacity for understanding what a man of science means by veracity, and an unconsciousness of the weight of established scientific truths which is almost comical.

There is no great force in the *tu quoque* argument, or else the advocates of scientific education might fairly enough retort upon the modern Humanists that they may be learned specialists, but that they possess no such sound foundation for a criticism of life as deserves the name of culture. And, indeed, if we were disposed to be cruel, we might urge that the Humanists have brought this reproach upon themselves, not because they are too full of the spirit of the ancient Greek, but because they lack it. The period of the Renaissance is commonly called that of the "Revival of Letters," as if the influences then brought to bear upon the mind of Western Europe had been wholly exhausted in the field of literature. I think it is very commonly forgotten that the revival of science, effected by the same agency, although less conspicuous, was not less momentous. In fact, the few and scattered students of nature of that day picked up the clew to her secrets exactly as it fell from the hands of the Greeks a thousand years before. The foundations of mathematics were so well laid by them that our children learn their geometry from a book written for the schools of Alexandria two thousand years ago. Modern astronomy is the natural continuation and development of the work of Hipparchus and of Ptolemy; modern physics of that of Democritus and Archimedes; it was long before modern biological science outgrew the knowledge bequeathed to us by Aristotle, Theophrastus, and Galen.

We cannot know all the best thoughts and sayings of the Greeks unless we know what they thought about natural phenomena. We cannot fully apprehend their criticism of life unless we understand the extent to which that criticism was affected by scientific conceptions. We falsely pretend to be the inheritors of their culture, unless we are penetrated, as the best minds among them were, with an unhesitating faith that the free employment of reason, in accordance with scientific method, is the sole guide to truth. Thus I venture to think that the pretensions of our modern Humanists to the possession of the monopoly of culture and to the exclusive inheritance of the spirit of antiquity must be abated, if not abandoned. But I should be very sorry that anything I have said should be taken to imply a desire on my part to depreciate the value of classical education, as it might be and as it sometimes is. The native capacities of mankind vary no less than their opportunities; and while culture is one, the road by which one man may best reach it is widely different from that which is most advantageous to another.

Again, while scientific education is yet inchoate and tentative, classical education is thoroughly well organized upon the practical experience of generations of teachers. So that, given ample time for learning and destination for ordinary life, or for a literary career, I do not think that a young Englishman in search of culture can do better than follow the course usually marked out for him, supplementing its deficiencies by his own efforts. But for those who mean to make science their serious occupation, or who intend to follow the profession of medicine, or who have to enter early upon the business of life—for all these, in my opinion, classical education is a mistake; and it is for that reason that I am glad to see "mere literary education and instruction" shut out from the curriculum of Sir Josiah Mason's College, seeing that its inclusion would probably lead to the introduction of the ordinary smattering of Latin and Greek. Nevertheless, I am the last person to question the importance of genuine literary education, or to suppose that intellectual culture can be complete without it.

An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of a cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that the Scientific College would turn out none but lopsided men. There is no need, however, that such a catastrophe should happen. Instruction in English, French, and German is provided, and thus the three greatest literatures of the modern world are made accessible to the student. French and German, and especially the latter language, are absolutely indispensable to those who desire full knowledge in any department of science. But even supposing that the knowledge of these languages acquired is not more than sufficient for purely scientific purposes, every Englishman has in his native tongue an almost perfect instrument of literary expression, and, in his own literature, models of every kind of literary excellence. If an Englishman cannot get literary culture out of his Bible, his Shakespeare, his Milton, neither, in my belief, will the profoundest study of Homer and Sophocles, Virgil and Horace, give it to him. Thus, since the constitution of the college makes sufficient provision for literary as well as for scientific education, and since artistic instruction is also contemplated, it seems to me that a fairly complete culture is offered to all who are willing to take advantage of it.

But I am not sure that, at this point, the "practical" man, scotched, but not slain, may ask what all this talk about culture has to do with an institution, the object of which is defined to be "to promote the prosperity of the manufacturers and the industry of the country." He may suggest that what is wanted for this end is not culture, nor even a purely scientific discipline, but simply a knowledge of applied science. I often wish that this phrase, "applied science," had never been invented. For it suggests that there is a sort of scientific knowledge of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed "pure science." But there is no more complete fallacy than this. What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those general principles, established by reasoning and observation, which constitute pure science. No one can safely make these deductions until he has a firm grasp of the principles, and he can obtain that grasp only by personal experience of the processes of observation and of reasoning on which they are founded. Almost all the processes employed in the arts and manufactures fall within the range either of physics or of chemistry. In order to improve them one must thoroughly understand them; and no one has a chance of really understanding them who has not obtained that mastery of principles and that habit of dealing with facts which is given by long-continued and well-directed purely scientific training in the physical and the chemical laboratory. So that there really is no question as to the necessity of purely scientific discipline, even if the work of the college were limited by the narrowest interpretation of its stated aims. And, as to the desirableness of a wider culture than that yielded by science alone, it is to be recollected that the improvement of manufacturing processes is only one of the conditions which contribute to the prosperity of industry.

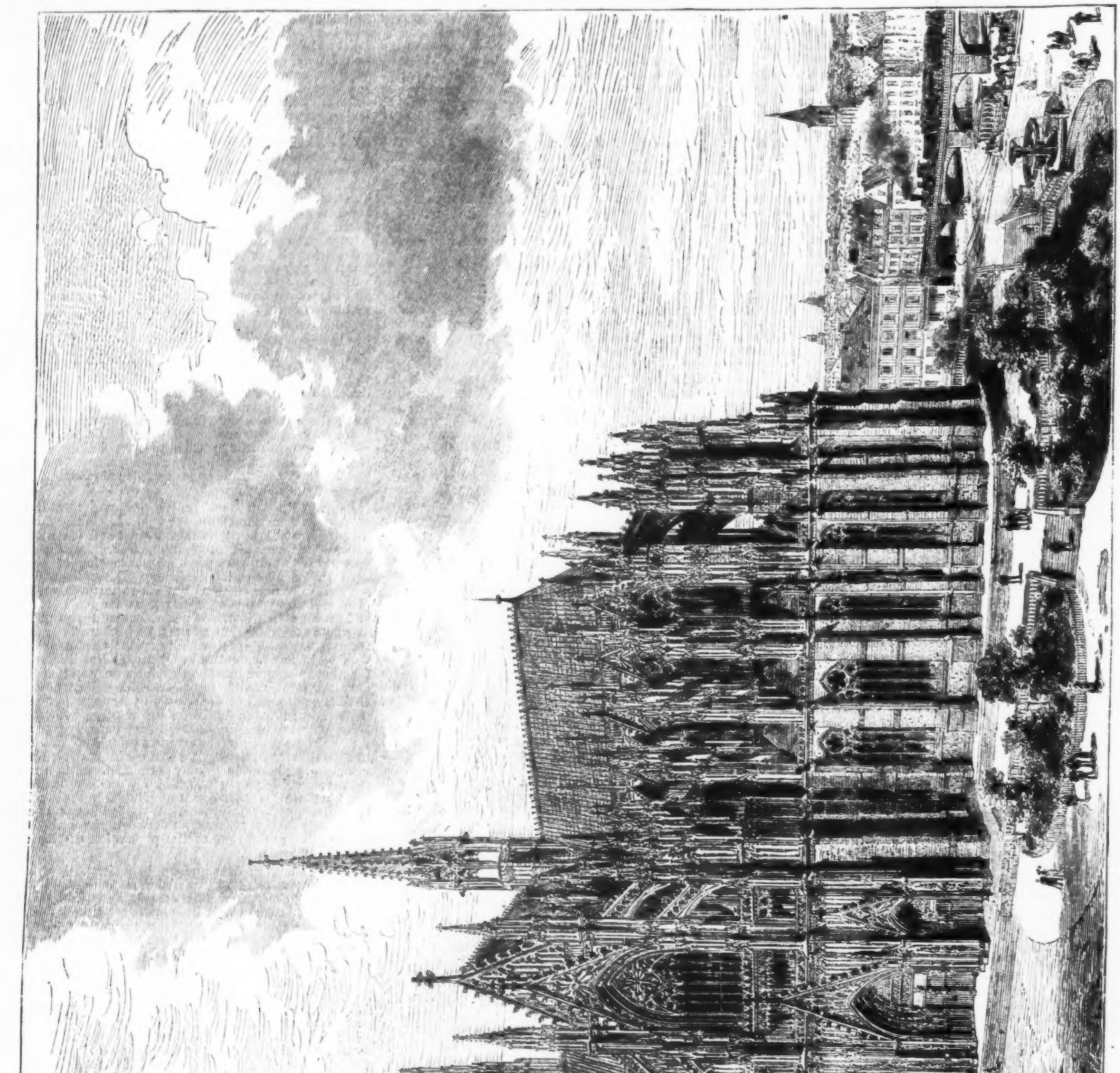
Industry is a means and not an end, and mankind work only to get something which they want. What that something is depends partly on their innate, and partly on their acquired, desires. If the wealth resulting from prosperous industry is to be spent upon the gratification of unworthy desires; if the increasing perfection of manufacturing processes is to be accompanied by an increasing debasement of those who carry them on, I do not see the good of industry and prosperity. Now, it is perfectly true that men's views of what is desirable depend upon their characters; and that the innate proclivities to which we give that name are not touched by any amount of instruction. But it does not follow that even mere intellectual education may not, to an indefinite extent, modify the practical manifestation of the characters of men in their actions by supplying them with motives unknown to the ignorant. A pleasure-loving character will have pleasure of some sort; but if you give him the choice he may prefer pleasures which do not degrade him to those which do. And this choice is offered to every man who possesses in literary or artistic culture a never-failing source of pleasures, which are neither withered by age, nor staled by custom, nor embittered in the recollection by the pangs of self-reproach. If the institution opened today fulfills the intention of its founder, the picked intelligences among all classes of the population of this district will pass through it.

No child born in Birmingham, henceforward, if he have the capacity to profit by the opportunities offered to him, first in the primary and other schools, and afterwards in the Scientific College, need fail to obtain, not merely the instruction, but the culture most appropriate to the conditions of his life. Within these walls the future employer and the future artisan may sojourn together for a while, and carry through all their lives the stamp of the influences then brought to bear upon them. Hence, it is not beside the mark to remind you that the prosperity of industry depends not merely upon the improvement of manufacturing processes, not merely upon the ennobling of the individual character, but upon a third condition—namely, a clear understanding of the conditions of social life on the part of both the capitalist and the operative, and their agreement upon common principles of social action. They must learn that social phenomena are as much the expression of natural laws as any others; that no social arrangements can be permanent unless they harmonize with the requirements of social statics and dynamics; and that in the nature of things, there is an arbiter whose decisions execute themselves. But this knowledge is only to be obtained by the application of the methods of investigation adopted in physical researches to the investigation of the phenomena of society.

Hence, I confess, I should like to see one addition made to the excellent scheme of education propounded for the college in the shape of provision for the teaching of sociology. For, though we are all agreed that party politics are to have no place in the instruction of the college, yet in this country, practically governed as it is now by universal suffrage, every man who does his duty must exercise political functions. And if the evils which are inseparable from the good of political liberty are to be checked, if the perpetual oscillation of nations between anarchy and despotism is to be replaced by the steady march of self-restraining freedom, it will be because men will gradually bring themselves to deal with political as they now deal with scientific questions, to be ashamed of undue haste and prejudice in the one case as in the other, and to believe that the machinery of society is at least as delicate as that of a spinning jenny, and not more likely to be improved by the meddling of those who have not taken the trouble to master the principles of its action. In conclusion, I am sure that I make myself the mouthpiece of all present in offering to the venerable founder of the institution which now commences its beneficent career our congratulations on the completion of his work, and in expressing the conviction that the remotest posterity will point to it as a crucial instance of the wisdom which natural piety leads all men to ascribe to their ancestors.

THE MILITARY PROGRESS OF JAPAN.

THE nation that may advance with hostile intentions against Japan a few years hence must be prepared to count the cost. In 1872 Japan established an arsenal at Tokio, Osaka, and Oji on plans furnished by French artillery officers. Three years later, so well had the native workmen learned their duties, the Tokio arsenal turned out 93,000 caps, 45,000 ball and blank cartridges, 101,000 Snider cartridges, and 20,000 rounds of artillery ammunition. At the Osaka arsenal during the first year of its completion 200 4-pounder bronze field guns were finished, and 100 4-pounder mountain howitzers, and 3,000 sets of harness and horse equipments.

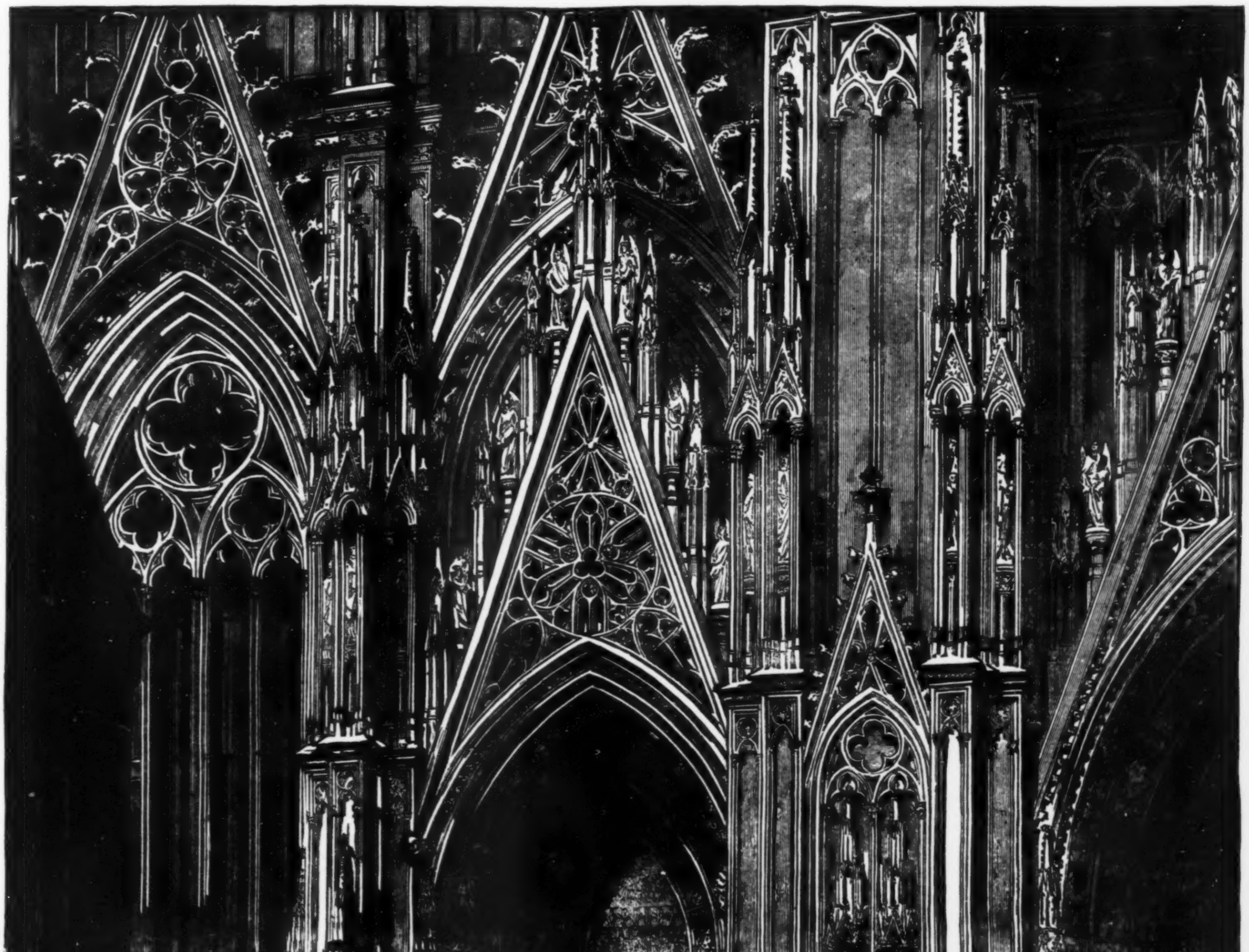


COLOGNE CATHEDRAL.

COLOGNE CATHEDRAL.

THE Emperor of Germany has performed the grand national ceremony of formally celebrating the completion of this magnificent edifice. Our illustrations comprise a general view of the cathedral, and one of the west front. The 15th of October, 1880, was the day appointed for this august solemnity at Cologne, which has the character of a significant historical event, being regarded by the Germans, Protestants and Catholics alike, as symbolic of their national unity, and as a type of the realization, at length, of those patriotic and romantic aspirations for Germany, visions of power and glory among the European states, long cherished by the literary and artistic studies of the last two generations. It is the triumph of what was called the Romantic School of German poetry, and of the political sentiment that was nourished by that school, after the decay of the purely classical or Hellenic school; but it is not now accompanied, as it might have been half a century ago, by a fresh exhibition of devotion to Catholicism in ecclesiastical relations. The actual conflict of authorities between Church and State in the German Empire is rather decidedly marked by the conspicuous absence of the Archbishop of Cologne from this notable celebration, though partly of a religious character, at the seat of his diocese. Times are changed, indeed, since the princely prelates of that See, in the Middle Ages, ranked among the most powerful electors of the "Holy Roman Empire."

One of these great archbishops, Conrad von Hochstaden, laid the foundation stone of Cologne Cathedral on August 14, 1248. There was a cathedral on that site before, which had been founded in the ninth century by the Frankish Emperor Charlemagne, but it had been destroyed by fire. The architect first employed in the present Gothic structure was Gerhard von Riehl, a native of the village of Riehl, near Cologne. It was not till 1332 that the choir was finished and consecrated by Archbishop Henry, of Virneburg, after which the building of the transepts was commenced. The southern tower was erected in the fifteenth century, and the



WEST DOOR OF COLOGNE CATHEDRAL.

bells were hung there in 1447. The conflicts in Germany which were occasioned by the Protestant Reformation, in the sixteenth century, stopped the progress of this grand edifice; and, for nearly two hundred and fifty years, it seemed likely never to attain completion, if not already doomed to perish of neglect. There was actually some intention of demolishing the north tower, for the purpose of widening the adjacent street. The interior was defaced by various unseemly additions and pretended decorations in the most tasteless style of the eighteenth century. The French Revolution, and the wars of Napoleon I., brought the rude hand of military violence to inflict still worse degradation upon the sacred pile; its interior was converted by one French army into a storehouse for hay and forage. That it was an object of German national pride would render it the more amenable to the insults of a foreign invader.

The Prussian monarchy, after the overthrow of Napoleon, looked upon the restoration, at least the preservation, of Cologne Cathedral as a token by which to pledge its rulers and people to the ultimate redemption of Germany. King Frederick William III., and his successor of the same name, bestowed serious attention upon this work, assisted by the official architects, Alhert and Zwirner, the second of whom prepared a scheme for the completion of the original design. On September 4, 1842, the first stone of the new construction was solemnly laid. A national subscription was opened to supply the funds, which have been steadily contributed by the Germans everywhere, since that time, without regard to provincial or religious distinctions. The sexcentenary festival, on August 14, 1848, was attended by the King of Prussia, and by the Austrian Archduke John, the elect President of the German Empire, then attempted to be established by the votes of a National Assembly. Notwithstanding the subsequent political reaction, the princes and the people of Germany continued to support this undertaking, which became indeed the symbol of their future reconciliation. It has survived the greater shocks of the war between Prussia and Austria in 1866, and the dissolution of the former Germanic Confederation. The fund raised for Cologne Cathedral, altogether exceeding one million sterling, was much augmented by the contrivance, in 1863, of a popular lottery for the pecuniary profit of this great public work. The architect Zwirner, who died in 1861, was succeeded by Herr Voigtel, the present architect of the cathedral, who now sees the work happily finished by the completion of the two lofty western towers.

The ground plan of the cathedral, which we lately described, is cruciform, as usual; the breadth of the nave, including two aisles on each side, is one hundred and forty-four feet; the total length of nave and choir is four hundred and sixty-six feet; and the length of the transept, which has two aisles, is two hundred and thirty-eight feet. The interior vault is one hundred and forty-three feet high; there are two rows of clustered pillars, one hundred and six feet high, around the nave and choir, and one row surrounding the transept. The west front, which has now been finished, is shown in our illustration on the preceding page. It presents a beautiful Gothic portal, with four recesses at each side, containing statues of saints and kings; the four great exterior buttresses are grooved and niched, admitting the same kind of decorative sculpture; and so are the openings for the two large windows, to the right and left, the upper parts of which are of the best geometrical Gothic design. The pediments, canopies, and pinnacles above are very richly adorned; and two tiers of tall canopied windows, four in each tier, occupy the higher portion of this front. The façade of the south transept is likewise elaborately decorated in the same manner, which, indeed, has been imitated in the west front. The general effect of the exterior view of the whole cathedral is shown in the large engraving on page 4094. The central tower, rising over the intersection of the nave with the transept, is three hundred and fifty feet high to the star that appears over its summit. But the two western towers, measuring their elevation from the pavement outside, attain the vast height of five hundred and twenty-four feet, or five hundred and fifteen feet from the basement; which is far greater than the altitude of any other building in Europe. The completion of this majestic cathedral will be a matter for great congratulations, as we have observed, among all who belong to the German race, and who call Germany their fatherland, though some of them dwell perhaps in this country, or in America, or other distant parts of the world.—*Illustrated London News.*

COLOGNE CATHEDRAL.

The completion of the Cathedral of Cologne was celebrated on Oct. 15, 1880, by a grand ceremony, in which the Emperor and Empress of Germany took a leading part. More than six hundred and thirty-two years have elapsed since the foundation stone was laid of the cathedral now but completed in the rough, on the site of an older Basilican structure The architect's name can only be conjectured from casual references to the building in contemporary chronicles. The present current of opinion sets in favor of ascribing the credit to one Gerard Von Riehl, as, in a document of 1257, it is stated: "Magister Gerardus lapicida rector fabricæ ecclesiæ majoris."

The story of erection seems, from the first, to have been one of a spasmodic, but when resolved upon, systematic, begging for funds throughout Europe; a fitful execution of repairs that little more than counterbalanced the natural decay of the fabric, followed by alternating periods of neglect and restoration. How the choir was consecrated in 1322; how, for a few years, progress was made with the foundations of nave and west front; how, one hundred and fifteen years after the opening of the choir, the bells were raised to the southwest tower; how at the beginning of the sixteenth century, just after the insertion of painted glass in the north aisle of the nave, the wave of the Reformation swept over Germany, diverting attention from the Cathedral at Cologne for three centuries; and how, in the second quarter of the current century, the work of building was taken up as a matter of national, rather than religious pride and duty, and carried forward with increasing energy to its completion; all this has been told ofttimes and well.

The superintending architects ("Dombaumeisters"), since the recommencement of the works in 1823, have been Albert, who acted on the reports of Schinkel; Ernst Zwirner, who succeeded at Albert's death in 1833; and more recently Voigtel. The outlay from 1842, when the Dombauverein, or association for the restoration and completion of the Cathedral, was established, to the end of 1878 was £380,000, and from 1822 to the present time about half a million pounds sterling have been expended.

The works of the past two or three years have been restricted to the raising of the twin stone spires on the western towers, and the redressing of the entire masonry in the southern tower, erected during the fourteenth century. In the first story of this tower, a great clock, by Mannhardt, of Munich, has been placed, and within it are hung a peal of five bells, of which the largest, the "Emperor" bell, cast from cannon taken during the Franco Prussian war, weighs twenty-five tons.

The ceremony performed last Friday included in its essentials a procession, in which were represented the workmen in the costumes of the different periods during the whole six and a third centuries through which the building has been in course of erection; followed by the affixing in the Dom Platz of the signatures of the Emperor and Empress and all the Federal princes and dignitaries of the Empire to a deed, which was then drawn up by machinery to the top of the southern spire, and inclosed within the capstone. The chief architect, Herr Voigtel, and the President of the Dombauverein are reported to have made long speeches in reply to the congratulations of the Emperor.

In conception, Cologne Cathedral marks an early period of the Gothic style; only a score of years later than Salisbury, it shows a considerably more advanced stage of architecture. A writer in the *Times*, after claiming for this building that it has done more than any other to sustain the character of that style throughout the times of the Palladian revival, and to bring about the change back to the Gothic style, criticises its weak points in words that justify quotation:

"The proportions seem rather mathematic than really æsthetic. The towers—over five hundred feet—are as high as the cathedral is long, which is not long enough for either internal or external effect. The external height of the roof is about equal to the width of the transepts—that is, more than 230 ft. The internal height of the building is over 160 ft., which is twice the usual internal height of our first-class cathedrals, and 60 ft. higher than the highest part of the interior of Westminster Abbey. Yet at Cologne the width of the nave and choir, without the aisles, is very little over 40 ft., and in that immense interior there is positively no space clear of pillars larger than a square of 40 ft. The extra width, therefore, is obtained by double aisles, and the result is a forest of tall pillars.

"Tourists with a quarter of an hour to utilize generally spend most of it in trying to see the roof, and make out some bosses of special beauty and interest; but the mere distance of that vaulting from the eye interferes with its effect as a vista stretching before the spectator, as well as above him. But there are graver faults even than these, or even than the dumpy and crowded effect of the exterior. The design wants originality. It wants free, inventive, and creative grace. It is an endless repetition of the same identical forms—the same pillars, the same windows, the same niches, the same mouldings, the same pinnacles, the same ornamental features. When you have seen a part you have seen all—that is, so far as the details are concerned. This seems to reduce the edifice to an enormous exaggeration and multiplication—a mere feat of ambitious arithmetic, instead of a work of true art."—*Building News.*

EVOLUTION.

During the late session of the American Association Professor A. Hyatt gave a popular lecture on the transformation of planorbis as a practical illustration of the evolution of species. The lecture was illustrated with stereopticon views. After the lecture Mr. Carl Seiler threw some microscopical illustrations upon the screen. Professor Hyatt spoke substantially as follows: The word evolution means the birth or derivation of one or more things or beings from others, through the action of natural laws. A child is evolved from its parents, a mineral from its constituents, a state of civilization from the conditions and surroundings of a preceding age. While evolution furnishes us with a valuable working hypothesis, science cannot forget that it is still on trial. The impatience of many when it is doubted or denied savors more of the dogmatism of belief than of the judicial earnestness of investigation. Every individual differs in certain superficial characters from the parent forms, but is still identical with them in all its fundamental characteristics. This constantly recurring relationship among all creatures is the best established of the laws of biology. It is the so-called laws of heredity, that like tends to produce like. There seem to be only two causes which produce the variations which we observe; one is the law of heredity, the other is the surrounding influences or the sum of the physical influences upon the organism. The first tends to preserve uniformity, the second modifies the action of the first. The law of natural selection asserts that some individuals are stronger or better fitted to compete with others, in the struggles of life, than are others of the same species; hence they will live and perpetuate their kind, while the others die out. An erroneous impression exists, that Darwinian doctrines are more or less supported by all naturalists who accept evolution, but it is far from the truth. The Darwinian hypothesis is so very easy of application, and saves so much trouble in the way of investigation that it is very generally employed, without the preliminary caution of a rigid analysis of the facts, and it is safe to say that it is often misapplied. A great amount of nonsense has been written about its being a fundamental law, in all forgetfulness that we are yet to find a law for the origin of the variations upon which it acts; it cannot be the primary cause of the variations, for the laws of heredity are still more fundamental. The speaker then described the situation and character of Steinheim; where numerous shells of the Planorbidæ are found in the strata, which have been very regularly deposited. Hilgendorf claims to have discovered great evidences of the gradual evolution of the various forms from the simplest and oldest specimens, but Mr. Hyatt has failed to find what Hilgendorf describes. By means of a lantern a number of illustrations of the shells were projected upon a screen, and were quite fully described. Four lines of descendants were shown to branch out from four of the simplest forms, with all the gaps between the species filled with intermediate varieties. Each one of the lines or series has its own set of characteristic differences, and its own peculiar history. It is a fair inference from the facts before us, that the species of the progressive series, which become larger and finer in every way, owe their increase in size to the favorable physical condition of the Steinheim basis. Darwinists would say that in the basin a battle had taken place, which only the favored ones survived. Mr Hyatt endeavored to present, in a popular manner, the life history of a single species, the *Planorba levis*, and its evolution into twenty or thirty distinguishable forms, most of which may properly be called by different names and considered as distinct species. He also endeavored to bring the conception that the variations which led to these different species were due to the action of the laws of heredity, modified by physical forces, especially by the force of gravitation, into a tangible form. There are many characteristics which are due solely to the action of the physical influences which surround them; they vary with every change of locality, but remain quite constant and uniform within each.

PSYCHOLOGY AND THE BABY—THE DEVELOPMENT OF MIND IN THE INFANT.

Most of the studies that have been made into the constitution of the human mind have been directed to that of adults, either sane or insane. Of late some investigation has been made into the intelligence of the lower animals. A recent work of a thousand pages, on "Mind in the Lower Animals," by Dr. W. L. Lindsay, gives evidence that we will have, some time, a comparative psychology.

But perhaps the most fruitful field for psychological investigation is that of infants and children. A recent writer in a contemporary review, commenting on this, says: "The psychological analysis of a single child is worth more than a whole menagerie; he who knows well the mind of a little boy or girl is already an expert in psychology." This is a field, however, which has been least of all investigated, though so close at hand that every parent can be something of a psychologist if he choose. Some indication of what a little careful observation can bring out is found in an article which has recently appeared from the pen of Professor W. Preyer, of Jena. We propose to give a few of the observations which he has made. If the facts are not all new, the professor's method of studying babies will, at least, prove novel to many.

This study must begin, he says, with the observation of the movements and sensations of the child; we must then note the development of the different senses, the formation of speech, and the effect of all these things in awakening the intelligence of the child. Movements begin first; they occur *in utero*; they are not reflex from peripheral sensations, but are the evidence of a superfluous nervous and muscular energy.

The first manifestation of voluntary motion occurs when the infant begins to hold up its head. Attempts to do this were noticed in the fourteenth week, and after four months the head was kept well balanced. Next after the head the upper part of the body was balanced; and the full power to sit up was acquired at the tenth month.

Ability to stand was, in the cases studied by Prof. Preyer, gained suddenly at the end of the first year. The movement of grasping sometimes takes place at a bound. A pencil is grasped mechanically, when put in the hand, in the first quarter year, but the action is wholly reflex. The first voluntary attempt to take hold of an object was observed in the seventeenth week. This first grasping was at once followed by many others of similar character. The child does not show self-consciousness, a knowledge of itself as an independent person, until after the fifth quarter year.

The sensibility of the skin of a new-born child is very low. We may stick needles into its nose, lips, or hands without its giving any sign of discomfort. The eyes of new born children close, when they are touched, more slowly than at a later period, and they do not close at all when wet in the bath. An increase of sensibility may be noticed in one or two days after birth. Prof. Kussmaul has shown that all new-born children can distinguish strong tastes. Taste, indeed, seems to be the first sense after that of sight, which affords clear perceptions to the baby. It is the first which gives occasion for the exercise of the faculties of memory and judgment. Infants distinguish odors very early, but to what extent has not been ascertained. Some animals born blind are guided to their food—the mother's milk—by this sense. Some odors, as tobacco-smoke, have been found unpleasant to young animals; others, as that of camphor, agreeable.

All infants are deaf at birth, because the outer ear is as yet closed, and there is no air in the middle ear. A response to a strong sound is observed, at the earliest, in six hours, but often, not for a day or two. The awakening of the sense may be observed by the irregular muscular movements and blinking which a loud noise occasions. No other organ contributes so much as the ear to the intellectual development of the child. This is shown by the intellectual backwardness of those born deaf compared with those born blind. The sense of hearing becomes early developed, so that the child soon distinguishes the different tones of those about him.

Light is at first unpleasant, and the infant shuts his eyes when brought to it. Brightness and darkness can alone be distinguished. The motions of the eyes are wholly unregulated. There is no real symmetry of movement before the first six days. The first perceptions are those of light. The child turns his head to the window within the first week. It is three weeks, however, before the eyes will follow a light that is moved before it.

The stupid expression on the child's face does not leave it until the second quarter year. The face then begins to grow more human and spirited as the power is gained of regarding objects with a steady, independent look. The faculty of accommodation is then developing. The power to distinguish colors follows that of intelligent attention. Children all prefer light and bright colors. But they can rarely distinguish them by name before the beginning of the third year.

The recognition of form, size, and distance, comes on slowly. It must be helped by the sense of touch. In the third year children will show ignorance of size, and inappreciation of distance. In the first month no notice is taken of the swiftest approach of a person's hand to the mouth, and the act of blinking, which is evidently acquired, does not take place till the third month.

The study of the growth of the faculty of speech has been pursued by Prof. Preyer with especial industry. He has set down upon paper every expression and sound that could be represented in writing, uttered by a child during its first two years. He informs us that at first only the vowels are heard. Even in the first five weeks, however, these sounds are so diversified as to express many different feelings of the child. Thus, according to Prof. Preyer, the periodically broken cry, with knit eyes, denotes hunger; the continuous whine, cold; the high, penetrating tone expresses pain. Prof. Preyer heard the consonant, *m*, during the seventh week; in the seventh month the consonants, *m*, *b*, *d*, *n*, *r*, and rarely *g*, *h*, and *k*, were distinguished. Very imperfect imitations of sounds were heard in the sixth month, and at this time voices began to be distinguished by the child. Great progress is made in the imitation of sounds after the third half year, and the powers of articulation become well developed by the fourth half year.

These are some of the observations that are given us. Very many of the professor's statements are based on but few observations, and it is very evident that there is a wide field for further study, and much that can be learned which

will be of value in the education of children as well as to pure psychology. It might be in the interests of science to commend matrimony to young men ambitious of psychological study.—*Medical Record.*

QUANTITY OF WOOL PRODUCED ON THE EARTH.

If we consider the enormous quantity of wool produced on our globe, we are tempted to wonder what becomes of it. From the production of South America Europe receives nothing with the exception of the River Plata wools and a small quantity which is imported with the sheepskins. The same is the case with the wool products of Asia. The skins which are imported from Persia, China, etc., are very few, and mostly goatskins. The quantity of wool imported, if we except India, is also comparatively small, and besides this these Asiatic wools are good only for certain purposes, like the wool of the North African coast. There is no doubt but that the wool industry of these countries has a great field before it in the future. At present we will speak only of the better kinds of wool, and of its consumption in Europe and the United States. Statistical notes can be given only up to 1878, and it will be interesting to compare the production of this year with that of 1830.

	1830. lb.	1878. lb.
Europe	280,000,000	740,000,000
River Plata	22,000,000	240,000,000
United States	10,000,000	208,000,000
Australia	6,000,000	350,000,000
Cape Colony	2,000,000	48,000,000
	320,000,000	1,586,000,000

In Europe, therefore, within the last fifty years the porduction has increased by 170 per cent.; but it would be erroneous to assume that this increase of production indicates that a greater number of sheep was raised in these countries; it is due rather to the fact that during this period such races of sheep have been chosen which give a great quantity of wool while the cultivation of the finer races has been abandoned. In other countries the increase has been still greater: in Montevideo the amount produced in 1878 was ten times as great as that of 1830; in the United States twenty times, in the Cape Colony twenty-four times, and in Australia sixty times as great. It is true that in these countries it is partly due to the greater number of sheep kept, but it is also due to the great improvements in the treatment of the wool; this is especially the case in Australia. All these countries, in regard to the machinery employed for this purpose, far excel Europe.

The quantity of wool consumed in the European States during 1878 is given in the following numbers:

	Consumption. lb.	Number of Spindles.	Laborers.
Great Britain	380,000,000	5,100,000	280,000
France	280,000,000	2,500,000	170,000
Germany	165,000,000	1,800,000	120,000
United States	250,000,000	1,400,000	120,000
Austria, Russia, Sweden, Belgium, Spain, a. o.	400,000,000	1,800,000	223,000
	1,575,000,000	12,600,000	913,000

The number of spindles and laborers we have given only because of their general interest. The wool production, according to our table, seems about the same for France as for England, but we must consider that the greatest part of the wool imported to France consists of River Plata wools, which render only about 30 per cent., and that the French buyers in the London market purchase much more of the heavy, sweaty wools than is used by the English industries. In truth, therefore, the wool consumption in France stands about as far behind that of England as the number of spindles does; perhaps even more. Another fact which is evident from the above tables is, that fifty years ago Europe furnished 88 per cent of all the wool produced, while in 1878 it furnished only 46 per cent.

This extraordinary increase in the production of wool in non-European countries has had a great influence upon the extension of wool industry, not only in so far as it supplied the first condition for this extension, viz., a sufficient quantity of the raw material, but also in so far as it supplied this latter at a low price, and thus effected a greater consumption of woolen goods. Besides, these countries are themselves good consumers of wool.

JUVET'S TIME GLOBES.

It is a curious fact that, notwithstanding the vast improvement, and, in some cases, the entire revolution that has been effected during the present century in the construction of astronomical and physical apparatus and in instruments of precision generally, no advance of any consequence has been made in the construction of artificial terrestrial globes for the last three hundred years. Indeed, the globes in use at the present day are almost precisely similar to those used by geographers in the middle of the last century; no improvement having been devised to render them less perishable, no changes in the method of mounting having been suggested to make them less clumsy, and no effort having been made to insure greater accuracy. Impressed with the idea that the faults and inconveniences of these old-fashioned globes were capable of remedy, and that so valuable and indispensable an object of instruction ought to be made equal in perfection of construction and in absolute accuracy to other educational apparatus of the present day, Mr. Juvet several years ago set himself to work at the problem, and finally resolved it in the production of his time globe, which we represent under three forms in the accompanying figures. In these globes (which are the result not only of M. Juvet's experiments, but also of the advice and suggestions of some of the ablest astronomers, physicists, and engineers in the United States) it is safe to say that perfection, as near as may be, has been obtained.

The time globe represented in Figure 1 contains in its interior a chronometer movement, which, thus situated, is effectually protected against accidents and dust. At the northern end the meridian ring is expanded into a holder for a transparent clock dial with the usual hour figures and minute divisions. The hands are situated under the dial, which is made of heavy plate glass, on which the time is easily read, while it interposes no obstacle to the free examination of any portion of the globe. The axis of the earth is represented by a gracefully shaped brass arrow, the feathered end of which is used as a stem-winder for the clock within, which runs four days, and is regulated from the outside. The meridian ring used for the support of the globe at its polar extremities is graduated for the measurement of latitude, and placed at some distance from the sphere to give lightness and beauty, and also to allow the examination of its surface more readily; while by means of a swiveled clutch and holder the sphere is readily adjusted to any position. The effect of this mechanical arrangement is that the globe is *hung in the air*, and no portion of its surface obscured—a great advantage over the antiquated style in which the cumbersome and awkward frame practically eclipsed the map of the southern hemisphere. At the equator a zone dial encircles the globe, the hour figures and minute marks on which, by following the meridian line of any locality to it, gives the exact time of any and every place. By the automatic movement of the clock, as it revolves on its

FIG. 1.

axis once every twenty-four hours, and by the new and simple arrangement above described, are shown the very motion of the earth, with the accompanying phenomenon of change from day to night; while at every moment there is exhibited on the equatorial dial the local time at all places on the earth; the day and night ring, at the same time, showing all the places at which the sun is then rising and setting, the relative length of the day and night in all latitudes, and all other circumstances attending diurnal rotations. Thus, as may be readily seen, all observations usually made with globes are here given as *object lessons*, and problems that relate to the causes of day and night and their constantly varying lengths, usually so incomprehensible to many, are solved in so simple a manner as to be readily understood, even by children, since we have here an exact representation of the phenomena of nature. The globe, in addition, also measures by its motion the comparative (and by a simple computation the *exact*) size of any country as it passes the meridian ring and equatorial zone.

FIG. 2.

The relative time globe and tellurian, shown in Figure 2, has a movable horizon or meridian, the mechanical appliances of which are entirely new, and the invention of Dr. Lyman, of the Sheffield Scientific School. It is mounted with full meridian or brass ring, graduated on both sides, held by a swiveled clutch, thus allowing the globe to be placed and held at any desired angle. It has also the equatorial time belt, with figures on the upper and lower surfaces, so that time may be obtained both north and south of the equator. This globe will not only solve *all* the problems given for an ordinary globe, but will also show the causes of the changes of the seasons, and, by means of the movable equatorial belt, the line of illumination for any day of the year. It also shows the time of the rising and setting of the sun, the axis of the earth still maintaining its proper position, universal time, etc., etc.

The clearness, fullness, beauty, and accuracy of the mapping of these globes are points worthy of note. The maps are a special edition of the celebrated Edinburgh ones (Johnston's), and are corrected up to date, so as to show all recent political changes and geographical discoveries (even the newly discovered *Herald Island*, in the arctic regions, is shown!); while blue lines exhibit average winter, and red lines the summer temperature of every country on the globe. Water is represented in blue of a desirable shade, and the ocean currents are clearly shown by white lines. Whenever a change in the boundaries of countries, the addition of states, or important geographical discoveries render it desirable, *these* globes, unlike the old style, can be remapped at a nominal cost

Messrs. Juvet & Co. also make a celestial globe (Fig. 3), which combines all the excellent features of the terrestrial. In this globe *the belt is movable.* In all celestial globes heretofore made observations have been taken by drawing the globe on the axis through the horizon. By such an arrangement, it most frequently happens that the globe moved eccentrically and thus became fixed. By a simple contrivance in the Juvet globe, invented by Prof. Saley, of Union College, the horizon itself is made movable, while the globe is stationary. By this means the annoying inconveniences attending the use of old style celestial spheres are practically overcome. By means of this globe all the phenomena connected with the apparent rotation of the celestial spheres may not be only rendered clear, but measured numerically; the time, for instance, of rising and setting of the sun, moon, and stars being directly indicated by the clock. It is, therefore a most valuable apparatus for the teacher in elucidating the first principles of spherical astronomy, as well as for the scientist in mechanically solving various astronomical problems.

Up to the present time it has been customary to manufacture globes from a mixture of glue and whiting—a combination liable to be softened by damp atmospheres or the process of washing, as well as to check and crack, and also to become yellow by age, and thus discolor the map and eventually render it worthless. All this work of building up the sphere from its paper foundation to its map surface was necessarily done by hand, rendering the completed sphere comparatively expensive. In the Juvet globes the material selected is papier mache, baked in a retort, and then sub-

FIG. 3.

mitted to enormous pressure to obtain compactness and uniform thickness and distribution of weight. The result of this is that a shell is obtained which, while as light as cork, is fully as resistant as steel. It will not fracture under heavy blows, it is unaffected by climatic changes, and may be washed, or even immersed in water without harm. In addition to this, the material being of equal thickness and weight in every part, the globes preserve an equable balance when finally mounted; and, although delicately centered on their axis, will not move a hair's breadth from the position to which they are turned. This is a very valuable feature and one not found in the old style globes, which, owing to the unequal distribution of weight in the shell, had to be held by one hand to keep them in a desired position during use.

By lessening the cost of manufacturing the shell, the inventor has been enabled to avoid the use of cast iron and other cheap mountings, and to substitute solid and polished brass for all the mechanical parts, without thereby increasing the cost of the complete apparatus. The whole mounting, whether of polished brass or of nickel-plated steel (which is furnished when preferred) is at once a model of elegance, lightness, stability, and convenience; and the finished globe, with its accurate time-piece, forms an apparatus as ornamental as it is useful, and one which will be found of great value, not only in the class-room, but also in the office, the study, and the parlor.

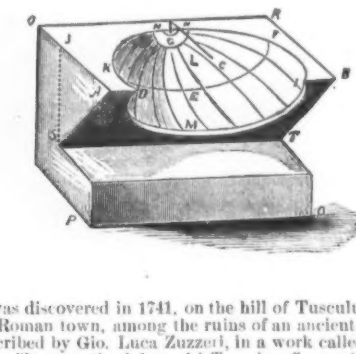
When the time globe was first publicly exhibited at the Centennial Exhibition, it at once excited the liveliest interest and the admiration of scientists generally, and so impressed was the Commissioner of the National Bureau of Education (Gen. Eaton) with its merits that he immediately ordered one for exhibition in his own department. It usually happens that astronomical instruments and apparatus of this nature are so expensive as to place them beyond the reach of the smaller institutions of learning and of families, but we are glad to see that these globes, notwithstanding their manifold improvements, are offered at prices that will allow them to be purchased by persons of quite moderate means. They are furnished of different sizes, ranging from 6 to 30 inches in diameter, but the same care is bestowed in the manufacture of the smallest as on the largest, and all are equally accurate. The works of the manufacturers, Messrs. Juvet & Co., are located at Canajoharie, N. Y.

At the recent fair of the American Institute, New York, these globes formed one of the most interesting and attractive of the exhibits. We have them in use in the offices of the SCIENTIFIC AMERICAN, and we speak from practical experience in saying that they are in all respects most excellent and desirable for constant reference.

AN OLD TIME PIECE.

By "ITHURIEL."

FIFTY feet beneath the pavements of London town lie the hearths, the worn out pave, the broken casements of the hamlet through whose lanes trod the soldiers of Cæsar, buried beneath the dust of ages and the *débris* of centuries. Not one in a thousand of the swarming myriads who hurry over them ever thinks of those mouldering relics, or thanks in his heart of the sturdy Britons who laid the foundation of a great city. So it has been said that "we of the new time stand on the shoulders of the ancients, to reach out heavenward." The schoolboy of to-day knows more of applied science than did Aristotle, the "father of science;" and as we raise our temples of industry on the ruins of what is old, hardly one of a hundred has time to think of, or thank, the patient toilers of old who, without instruments, books, or guiding rules, by slow process of patient thought, wrought out the principles that make science an entity, and render intelligent handicraft a possibility. But to thinking workmen the relics of the past have ever a positive interest, as showing out of what small beginnings our arts have sprung. An object, well calculated to arouse such feeling, is the old Roman time-indicator shown in the illustration.



It was discovered in 1741, on the hill of Tusculum, an ancient Roman town, among the ruins of an ancient villa, and is described by Gio. Luca Zuzzeri, in a work called "*D'una antica villa scoperti sul dosso del Tusculo e d'un antico orologio a sole.*" Venezia. 1746.

It is of a kind said to have been invented by Berosus, who was a priest of Babylon in the time of Alexander the Great. He acquired the Greek language, removed to Greece, and opened a school of astronomy and astrology in the island of Cos, where he acquired great fame.

Such sun dials as this were in quite general use among the Romans during the latter days of the republic and empire, so we cannot certainly fix its date. It could well be of the time of Julius Cæsar or older.

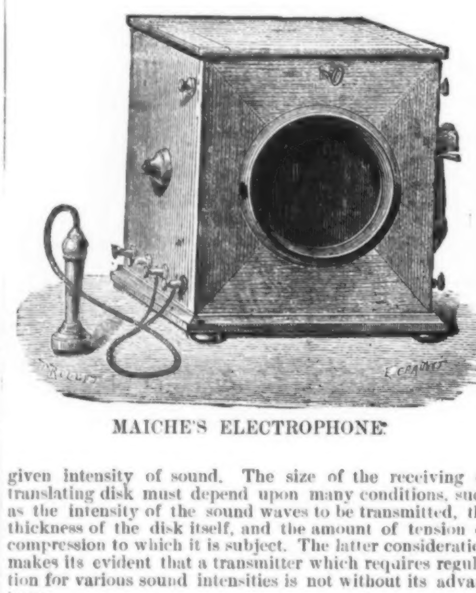
The breadth as well as the height (A O and P A) are a little more than eight inches, and the length (A B) somewhat more than sixteen inches. The surface (A O R B) is horizontal. S P Q T is the base of the *solarium*, as it was called, which probably stood upon a pillar. The side, A S T B, inclines somewhat toward the base. This slant shows the latitude or polar altitude of the place for which the solarium was made. The angle of this one is about 40° 43', which corresponds with the latitude of Tusculum. In the body of the solarium is the almost spherical hollow, H K D M I F N, which forms a double hemicycle. Within this excavation are marked eleven hour lines, which pass through three semicircles, H L N, K E F, and D M I. The middle one, K E F, represents the Equator, the two others the tropic lines of winter and summer. The curve for summer is somewhat more than a semicircle, the two other curves are smaller. The ten middle parts or hours in each of the three curves are all equal to each other, but the two at the extremes, while equal to one another, are one-fourth smaller than the rest. In the middle, G, of the curve, D K H N I J, there is a little square hole in which the gnomon, or pointer, must have stood. A trace of it is still visible in the lead, by means of which it was fixed. It must have stood in a perpendicular position upon the surface, A B R O, and at a certain distance above the surface it must have turned in a right angle above the spherical excavation, so that its end, C, stood out as far as above the middle of the equatorial line, as shown in the cut, which represents the solarium as restored by Zuzzeri.—*Jeweler's Journal.*

MAICHE'S ELECTROPHONE.

THE system of telephonic communication designed by M. Louis Maiche consists of an ordinary Bell or Gower telephone, and a special transmitter or electrophone contained in a wooden box, about ten inches square, indicated by the letters A A on the accompanying engraving, which we reproduce from *L'Electricite.*

The interior of the wooden box is occupied by a glass dish, B, bedded in the wadding, C C. This glass dish receives the sound waves produced by the voice, and translates the vibratory movement of the air into mechanical motion, and is, therefore, a substitute for the diaphragms of other transmitters. Immediately above the glass dish, and in contact with each other, are two balls (marbles) of carbon, D, one above the other, secured to the end of two wires, hinged or pivoted to the sides of the box at E E. The lower of these two carbon balls rests upon the upper outside of the glass dish, without any other pressure than that due to gravity. When the sound waves set the glass dish in vibration, it will be obvious that the balls of carbon will press against each other with a varying force due to the vibrations of the disk. It is well understood that if two blocks of carbon in contact, forming part of an electric circuit, be subject to varying degrees of pressure, there will arise corresponding variations of resistance to the current, and consequent variations of potential in the circuit, which are revealed as sound in the telephone. The carbon balls, D, with their connecting wires, and the pivots or hinges, E, form part of the circuit of a local battery, which also includes the primary wire of the induction coil, F. One end of the secondary wire of the induction coil is carried to earth, and the other is connected to the line wire connecting the home and distant stations, in the same manner as in the Blake or Crossley transmitter. The switch for cutting out the battery when not in use is not shown in the engraving, but as it is precisely similar to that ordinarily employed, its arrangement will be perfectly familiar to our readers.

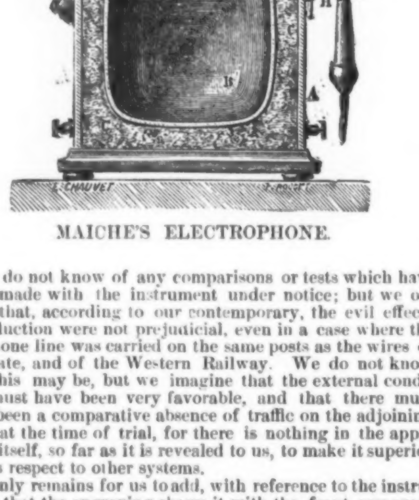
It is claimed for this electrophone that it never requires regulation, and this, we think, may be granted for it, provided that it is properly constructed in the first place. It exhibits a new departure in transmitter construction, and, so far as we can see, we think it should give fairly good results. The inventor points out that the glass dish presents a surface more than one hundred times greater than the disk of a Bell telephone, and that it, therefore, acquires a greater amount of mechanical vibration under the action of the sound waves, and imparts to the carbon balls a very much greater range of pressure, and, therefore, greater variation of the intensity of current, than can be derived from the smaller disk, while its concave form enables it to translate the sound waves into mechanical motion more readily than a flat surface of the same area. The intensities of these effects, moreover, permit the carbon balls and their supporting wires to have such dimensions and weight as shall insure perfect stability, and place them beyond risk of derangement. The inventor may be perfectly correct in his assumptions, but we have long since found that the mere increase of size of the disk or diaphragm does not by any means increase its value. In every variety of transmitter we have tried we have invariably found that there is a particular size of disk which gives the best result for a



MAICHE'S ELECTROPHONE.

given intensity of sound. The size of the receiving or translating disk must depend upon many conditions, such as the intensity of the sound waves to be transmitted, the thickness of the disk itself, and the amount of tension or compression to which it is subject. The latter consideration makes its evident that a transmitter which requires regulation for various sound intensities is not without its advantages.

At the recent Leeds Musical Festival transmitters were erected in the concert hall, and connected with telephones in a distant room. It was then found that the solos and many parts of the music were represented by a dead silence, while the choruses were satisfactorily reproduced. It would be practically impossible, we conceive, says *Design and Work*, for any transmitter to convey such wide variations of sound as were there presented, without a constant regulation, which it would be practically impossible to achieve. It might, however, have been very possible to have had previously regulated transmitters, fixed with a separate circuit and telephone for each transmitter, and by this means to have heard the whole of an oratorio at a distance. We cite this only as an example of one of the disadvantages attending the use even of the best transmitters, under exceptional circumstances, and to disabuse the minds of some of our readers, who, judging from their communications, seem to imagine that all sounds, of whatever magnitude or complexity, may, with equal facility, be reproduced.



MAICHE'S ELECTROPHONE.

We do not know of any comparisons or tests which have been made with the instrument under notice; but we observe that, according to our contemporary, the evil effects of induction were not prejudicial, even in a case where the telephone line was carried on the same posts as the wires of the State, and of the Western Railway. We do not know how this may be, but we imagine that the external condition must have been very favorable, and that there must have been a comparative absence of traffic on the adjoining wires at the time of trial, for there is nothing in the apparatus itself, so far as it is revealed to us, to make it superior in this respect to other systems.

It only remains for us to add, with reference to the instrument, that the engraving shows it with the front removed. The missing part consists simply of a plain piece of board, hinged to the box, and perforated with a central hole about five inches in diameter.

EXPERIMENTS FOR BEGINNERS.

"Do as you're bid and ask no questions," used to be the admonition administered to the inquisitive youth when newly installed in the dye house as a learner. The busy foreman was ready to show how colors should be extracted and mordants prepared, but he had no time to explain the causes of the chemical changes he produced. At least he said he hadn't, and if there was any other reason why he withheld his explanations he certainly never referred to it. Since that time dye stuffs have multiplied, processes become more complex, and explanations of them more tedious and difficult. The young dyer must still rely mainly upon self-help. In public libraries text books on his art are rare, and if he is the fortunate owner of one he finds it to be too advanced for him, unless he has well mastered the rudiments of chemistry. No science demands of its learner a more careful study of general elementary principle, and none rewards him better for acquiring them. In doing so he will find his progress very much facilitated by experiments, provided he confines himself to those which serve to elucidate the lesson before him. Experiments, if not well chosen, may confuse rather than aid; nay, their performance may degenerate into a mere pastime. While, then, he may safely be left to prosecute them, he will need in the beginning to be assisted in selecting them, and perhaps in deriving from them all that they can teach him. This assistance we propose to give him, assuring him that a few of the simplest experiments performed by himself with substances and small vessels to be found either in the dye house or at home, will, if thoroughly understood, serve to make clear many of the otherwise obscure and puzzling passages in his books.

Experiment 1.—Melt an ounce of lead in a clean iron ladle. The surface of the liquid, at first almost as bright as silver, becomes coated with a bluish scum or powder. Stir with a clean iron wire, and occasionally, with a pair of bellows, blow air over the surface so gently as not to throw out the powder. This will increase until all the metal has been converted into it. It will partially change to a fawn color, and when weighed will be more than an ounce.

Explanation.—The increase in weight did not come from the ladle or the wire, for they are not abraded; it must therefore have been derived from the air which came in contact with the molten metal, and the powder is composed of lead and one of the constituents of the atmosphere. If you compare this powder with that marked "Litharge" in the dye house collection, you will see so close a resemblance as to be satisfied that you have indeed made litharge yourself. Now this substance is known to be composed of lead and the gas oxygen. By stirring the lead in the ladle, and blowing upon it, you caused it to combine with oxygen, one of the gases composing air. Using the sign + to indicate addition, you may express the operation which you have performed thus: Lead + Oxygen give Litharge; or remembering that the Latin word for lead is *Plumbum*, and that chemists represent it by the first and last letters of its first syllable, Pb, for the sake of brevity, and that they, for the same reason, represent oxygen by its initial letter, O, you, by substituting the sign = for the word *give* in the above expression, have

$$Pb+O=PbO;$$

indicating that the lead and the oxygen have united to form litharge, the composition of which is lead and oxygen. Now it must be evident that, because the oxygen of the air had an attraction for the lead, it left the elements with which it was mingled in the air and united itself with the metal. The experiment well illustrates the effects of chemical attraction, or, as it is called, affinity. Among these effects you observe an entire change of properties. The litharge resulting from the union of lead and oxygen resembles neither. The qualities which characterized the metal, as well as those which distinguished the gas, have all disappeared, and in their place you find those of a dull, fawn colored powder—litharge. Chemists call litharge *oxide* of lead, using the termination *ide* after the first syllable of the word oxygen.

You have now learned how litharge is made, what change takes place during the operation, and why and how this change may be briefly expressed according to the form used in works on chemistry.

Experiment 2.—Put about a teaspoonful of the litharge (oxide of lead) in a tumbler, pour upon it about one-quarter of a tumbler of strong vinegar, or, as vinegar owes its sourness to acetic acid, about one-third as much of that acid; cover the tumbler with paper to keep out dust, and set it aside in a warm place. In two or three days much of the oxide of lead will have disappeared. Pour off the liquid carefully into a bottle, leaving all of the undissolved oxide of lead behind, cork the bottle tightly, label it distinctly "poison," and wash out the tumbler.

Explanation.—The chemical attraction, or, better, the *affinity* existing between the oxide of lead and the acetic acid is sufficient when they are placed in contact as above directed to cause them to combine, forming a compound commonly called sugar of lead, and called by chemists the *acetate* of lead, the termination *ic* of the acid being replaced by *ate* when speaking of the compound. The change may be thus expressed:

Oxide of Lead + Acetic Acid = Acetate of Lead.

The properties of the powdered oxide and the liquid acid both disappear as combination takes place, and the resulting acetate when pure is sold in the form of crystals.

Observing the strength of the force which first caused the oxygen to leave the atmosphere and unite with the lead in the ladle, and which still retains it in combination, you will naturally wish to measure the force of affinity. This can not be done absolutely, but it may be comparatively—that is to say, you can determine whether the affinity between oxygen and lead is greater or less than that which exists between oxygen and some other metal, for example, zinc.

Experiment 3.—Pour into a wine glass from the bottle containing the solution of acetate of lead, about a teaspoonful, and into the remainder drop a small piece of zinc; cork, and put it where it will not be disturbed for a day or two. Beautiful, bright metallic particles will be seen covering the zinc. These particles are pure lead.

Explanation.—A portion of the oxide of lead, which combined with acetic acid to form the acetate of lead, has been deprived of its oxygen by the zinc. The change may be thus expressed, Zn being taken as the *symbol* for zinc.

$$PbO+Zn=ZnO+Pb.$$

The stronger affinity existing between zinc and oxygen caused the latter to leave the lead, and the newly-formed oxide of zinc united with the acetic acid to form acetate of

zinc. The ability of zinc to decompose oxide of lead may be shown in what is called a

Table of Decomposition.

Oxygen.

Zinc.
Lead.

The metal whose oxide is decomposed more easily is placed below. When you find this list extended, as is generally the case in text books, so as to include all the metals arranged according to their affinities for oxygen, you should copy it, and post it up in the dyehouse.

You can also determine whether the affinity between the oxide of lead and acetic acid is greater or less than that which exists between that oxide and some other acid, for example, sulphuric.

Experiment 4.—To the teaspoonful of acetate of lead which you poured into a wine glass and kept covered, add about a tablespoonful of pure water, and then add a few drops of sulphuric acid. The solution, previously clear, instantly becomes turbid, and a heavy white powder sinks to the bottom.

Explanation.—This powder is the insoluble sulphate of lead. Sulphuric, the master acid, unites with the oxide of lead, liberating the acetic acid, which remains in the solution. The action may be thus expressed: Acetate of Lead+Sulphuric Acid=Sulphate of Lead+Acetic Acid; or, further to aid the memory in the form of a table of decomposition:

Oxide of Lead.

Sulphuric Acid.
Acetic Acid.

When an acid combines with an oxide of a metal the resulting compound is called a salt, and you have here the decomposition of one salt, the acetate of lead, by a stronger acid than the acetic, and the formation of another salt, the sulphate of lead.

The affinity of the oxides of zinc and of lead for the acetic, a vegetable acid, you have seen to be quite marked, but their attraction for vegetable dyes is too weak to merit your attention now. The oxide of aluminum, known as alumina, has, on the contrary, a powerful attraction for those dyes, as a few days' experience at the dye vat will teach you. But this attraction for the several vegetable coloring principles is not equal, and you may measure its relative power as readily as you can that of an oxide for an acid. Nor need you specially prepare your alumina. You have but to take advantage of its preparation for use on a large scale, and have a test piece of cotton cloth "mordanted" with the other goods. With this piece you may test the relative attraction of alumina for at least three important vegetable dyes, viz., quercitron, logwood, and madder.

Experiment 5.—First immerse the cloth mordanted with alumina in a decoction of quercitron bark. This imparts to it a fast yellow color. Wash well, then put it into a hot decoction of logwood. The color of the cloth will gradually be changed from yellow to purple. Rinse, and immerse it for several hours in a hot solution of madder, and the purple cloth will become red.

Explanation.—The yellow compound of alumina and quercitron, when immersed in the decoction of logwood, was decomposed; the quercitron being set free by the greater attraction existing between logwood and alumina. So when the purple cloth is kept in the hot solution of madder, the superior attraction of this dye for alumina sets free the logwood.

You are, therefore, with alumina and the three dyes, able to make the following table of decomposition:

Alumina.

Madder,
Logwood,
Quercitron.

The dye which has the greatest attraction for the metallic oxide being placed first under it, the others following in order.

The formation of litharge in the first experiment illustrates how oxides are composed. The production of the acetate of lead in the second experiment, by the union of the oxide of lead with the acetic acid, shows how a *salt* is formed by the combination of an acid with a metallic oxide. The separation of oxygen from lead in the third experiment, by taking advantage of the superior affinity existing between zinc and oxygen, is a case of chemical decomposition well worthy of repetition. It is one of a large number of interesting transformations of oxides. The decomposition of the acetate of lead in the fourth experiment by the stronger attraction of sulphuric acid for the oxide of lead, the formation of the insoluble sulphate of lead, and the consequent setting free of the acetic acid, elucidate the transformations of mineral salts; while the fifth experiment carries these transformations among the coloring matters, and demonstrates that the laws of decomposition control the operations of the dye vat.—*Textile Record.*

ON THE ACTION OF OILS ON METALS.*

By WILLIAM HENRY WATSON, F.C.S., etc.

AT the Plymouth meeting of this association I brought forward the results of some experiments, showing the actions of various oils on copper, and the conclusions arrived at were briefly these:

1. That of the whole of the oils used, viz., linseed, olive, colza, almond, seal, sperm, castor, neatsfoot, sesame, and paraffin, the samples of paraffin and castor oils had the least action, and that sperm and seal oils were next in order of inaction.

2. That the appearances of the paraffin and the copper were not changed after 77 days' exposure.

3. That different oils produce compounds with copper varying in color, or in depth of color, and consequently rendering comparative determinations of their action on that metal from mere observations of their appearances impossible.

I was disposed to conclude that these experiments would indicate the relative action of the oils on other metals, simply expecting that the extent of action would vary throughout, but that the variations would be proportionate between the different oils.

Since the publication of these results, however, an interesting paper has appeared (*Pharm. Journ.*), "On the Action of Paraffin Oils on Metals," by Dr. S. Macadam. He comes to the same conclusion as myself with regard to their action on copper, but referring to iron, says "it is slightly affected by paraffin oil, and on ten days' contact the oil becomes deeper in color and throws down a fine ferruginous sediment." Owing to this, I have lately made experiments on the action of the same oils as those previously used on copper, on iron, and the results, which are the subject of this communication, are interesting to me as showing that there is no relation between the action of an oil on copper and the action of that oil on iron; that, in fact, in several instances those oils which act largely on iron, act slightly on copper, while those which act largely on copper act little on iron. Of course the actual extent of action of the same oil (with the exception of paraffin) is greater on copper than on iron.

In addition to the oils used in my experiments on copper, I also used a sample of refined lard oil, and a special lubricating oil prepared by the Dee Oil Company, near Chester. The following observations were made, after twenty-four days' exposure:

1. *Neatsfoot.*—Considerable brown irregular deposit on metal. The oil slightly more brown than when first exposed.

2. *Colza.*—A slight brown substance suspended in the oil, which is now of a reddish brown color. A few irregular markings on the metal.

3. *Sperm.*—A slight brown deposit, with irregular markings on the metal. Oil of a dark brown color.

4. *Lard.*—Reddish brown, with slight brown deposit on metal.

5. *Olive.*—Clear and bleached by exposure to the light and air. The appearance of metal same as when first immersed.

6. *Seal.*—A few irregular markings on metal. The oil free from deposit, but of a bright clear red color.

7. *Linseed.*—Bright deep yellow. No deposit or marks on metal.

8. *Almond.*—Metal bright. Oil bleached and free from deposit.

9. *Castor.*—Oil considerably more colored (brown) than when first exposed. Metal bright.

10. *Paraffin.*—Oil bright yellow and contains a little brown deposit. The upper surface of the metal on being removed is found to have a resinous deposit on it.

11. *Special Lubricating.*—Metal bright. Appearance of oil not perceptibly changed.

The samples were then chemically examined, and the amounts of iron found in them were as follows:

Neatsfoot oil (English)	0·0875	grain.
Colza "	0·0800	"
Sperm "	0·0460	"
Lard "	0·0250	"
Olive "	0·0062	"
Linseed "	0·0050	"
Seal "	0·0050	"
Castor "	0·0048	"
Paraffin "	0·0045	"
Almond "	0·0040	"
Special lubricating oil	0·0018	"

For comparison, the following are the results obtained of the action of these oils on copper, as previously communicated, after exposure of ten days:

	Copper found.	
Neatsfoot oil	0·1100	grain.
Colza "	0·0170	"
Sperm "	0·0030	"
Olive "	0·2200	"
Linseed "	0·3000	"
Seal "	0·0485	"
Paraffin "	0·1015	"
Almond "	0·1050	"

Owing to the length of exposure being different in the two series, we cannot fix on the actual differences in the *rate* of action of any of the oils on the two metals. However, it is shown that almond oil, which acted largely on copper acts very slightly on iron; in fact, with the exception of the paraffin and special lubricating oil (a mineral preparation), it acted less than any of the other oils on iron. The same is shown, as already mentioned, as to the action of various other oils; thus, while sperm oil acts slightly on copper, it acts considerably, compared with the others, on iron. Linseed, seal, castor, almond, and paraffin may be bracketed as having about the same and very little action on iron, while linseed, olive, neatsfoot, almond and seal have the greatest action on copper.

* Read before the Chemical Section of the British Association, Swansea Meeting, 1880.

PRUSSIC ACID AND A NEW ALKALOID IN TOBACCO SMOKE.

DR. LE BON has communicated to the *Journal de Therapeutique* a paper "On the Existence in Tobacco Smoke of Notable Proportions of Prussic Acid, and on the Existence of a New Alkaloid." He comes to the following conclusions:

1. The principles of tobacco smoke, which are condensed by cooling in the mouth and lungs or in the apparatus destined to collect them, contain nicotine, carbonate of ammonia, various tarry matters, coloring substances, prussic acid combined with bases, and very odorous and very poisonous aromatic principles. In the smoke these various substances are found mixed with a large proportion of the vapor of water and of various gaseous compounds, principally the oxide of carbon and carbonic acid.

2. The liquid resulting from the condensation of the preceding substances is endowed with extremely poisonous properties. It suffices to inject very small quantities into the circulatory system of an animal, or to cause it to be respired for some time, to induce death, after the exhibition of various signs of paralysis.

3. The properties of tobacco smoke, which up to the present time have been attributed solely to nicotine, are also due to prussic acid and to various aromatic principles, especially an alkaloid, *collidine*. This is a liquid body of an agreeable and very penetrating odor, the presence of which had been exhibited in the distillation of various organic matters, but the physiological properties of which were entirely unknown. It contributes in great part to giving its odor to tobacco smoke; and so penetrating is its perfume that but a single drop suffices to impart a very strong odor to a large quantity of water.

4. Collidine is an alkaloid as poisonous as nicotine. The twentieth part of a drop kills a frog rapidly, producing symptoms of paralysis. Only a few instants breathing it induces muscular debility and vertigo.

5. It is to the presence of prussic acid and the various aromatic principles that several phenomena are due, such as vertigo, pain in the head, and nausea, which are produced by certain tobaccoes, either poor in nicotine or destitute of it, while other tobaccoes, rich in nicotine, do not produce any analogous effects.

6. The proportion of prussic acid and aromatic principles contained in tobacco smoke varies in different tobaccoes, those of Havana and the Levant containing the strongest doses.

7. The black semi-fluid matter which condenses in the interior of pipes and cigar holders contains all the substances enumerated, and especially large quantities of nicotine. It is extraordinarily poisonous, two or three drops sufficing to kill an animal of small size.

8. The combustion of tobacco destroys only a small part of the nicotine which it contains, so that this is found in great part in the smoke. The proportion susceptible of being absorbed by smokers, and which we have determined in our experiments, varies according to the conditions in which these latter are placed. It is scarcely ever less than 50 centigrammes in each 100 grammes of tobacco smoked. The quantity of ammonia absorbed at the same time is about equal.

9. Of the different modes of smoking, that in which the amount of nicotine and the various other principles absorbed is greatest, is smoking so that the smoke is respired; that in which the proportion is least, is smoking the narghal or pipe with a long tube in the open air, without respiring the smoke.

10. Nicotine kills animals instantly in doses of two or three drops, but in infinitely smaller doses it causes paralysis and death. A frog introduced into a vessel containing an aqueous solution of nicotine at one-two hundred thousandth, or about one drop to a liter of water, succumbs in some hours. The same occurs if the frog be placed under a funnel containing a single drop of nicotine in a roll of cotton wool. The vapor disengaged from nicotine while boiling kills animals instantly, without leaving them time to move.

11. Tobacco smoke contains about eight liters of oxide of carbon per 100 grammes of tobacco burned. Our experiments prove that it is not to this gas that it owes its poisonous properties.

12. Among the most certain effects which the smoke of tobacco determines in the long run in man, may be mentioned visual disturbances, palpitations, tendency to vertigo, and especially diminution of memory.

LIQUEFIED OZONE.

IT has been recently found by MM. Hautefeuille and Chappuis that the production of ozone in oxygen by the silent electric discharge in M. Berthelot's apparatus for that purpose is greatly influenced by temperature. Thus in passing from 20° to —55° the proportion of ozone obtained was nearly quintupled. Increase of pressure has a like effect, but much less in amount for each temperature. By reason of these observations the authors have been enabled to submit portions of largely ozonized oxygen to the action of increasing pressures in M. Cailletet's apparatus (in which it is known mercury acts by pressure on a gas in a strong capillary tube). The capillary tube was kept at a temperature of —23°. From the first strokes of the piston the gas in the tube assumed a blue color, deepening to indigo blue when the tension of the ozone had reached several atmospheres. A sudden decompression or release of pressure from 75 atmospheres, gives rise to a thick, blue mist, a certain sign of liquefaction of the ozone. To get a corresponding mist with pure oxygen requires a previous compression to 300 atmospheres. On the other hand, ozone seems a little less easy to liquefy than carbonic acid. It would appear, further, that ozone is to be numbered among explosive gases. If the mixture of oxygen and ozone referred to be not compressed slowly and kept cool, the ozone is decomposed with liberation of heat and light. A strong detonation is heard, accompanied by a yellowish flash. The blue color (it is remarked) is as characteristic of ozone as the odor of the gas, for it may be observed with all tensions, if a sufficient thickness of the gas be looked through.

ACTION OF SULPHURIC ACID ON PLATINUM.

By SCHEURER-KESTNER.

THE action of chamber vitriol on the platinum retorts used in the process of concentration is due to the presence of a very minute trace of oxides of nitrogen, which give scarcely any reaction with ferrous sulphate, but may be detected by means of the blue color formed by diphenylamine. The solvent action is greater the greater the concentration of the acid. The oxides of nitrogen exist in the oil of vitriol in presence of selenium and sulphurous anhydride, and are apparently in a state of stable combination, since they are not expelled during the process of concentration, whereas all the sulphurous anhydride is given off. A very minute trace of nitrogen oxides, which appear to act as intermediate agents in the oxidation of the platinum at the expense of the oxygen of the sulphuric acid, is consequently sufficient to cause continuous solution of the platinum so long as the oil of vitriol remains in contact with it. If, however, the oil of vitriol be previously boiled with a little ammonium sulphate, all the oxides of nitrogen are destroyed, and the action on the platinum is prevented. Perfectly pure sulphuric acid does not attack platinum even when heated with it in closed tubes at the boiling point of sulphur.—*Compt. Rend.*

SULPHUR IN COAL.

By W. WALLACE.

IT has been assumed that sulphur exists in coal chiefly, if not entirely, as iron bisulphide. Crace-Calvert has asserted that in some cases it is partly present as sulphates. The author shows that in some coals the sulphur chiefly exists as an organic compound. The following table shows the relative quantities of total sulphur and that existing as pyrites, assuming all the iron found in the ash to have been present as bisulphide:

	Total sulphur per cent.	Sulphur as bisulphide per cent.
Ell coal (Lanarkshire)	0·91	0·11
Main coal "	0·60	0·42
Splint "	0·46	0·14
Pyotshan "	0·68	0·17
Soft coal from Fife	0·93	0·49

The estimations of sulphur were made by Pattinson's method, and also by fusion with sodium carbonate and potassium nitrate. The Ell coal was found by Crace-Calvert's method to be free from sulphates, the others were not tested.—*Chem. News.*

SILVER SULPHATE.

By PHILIP BRAHAM, F.C.S.

THE silver sulphate was shown as brilliant transparent crystals of high refractive power. They were produced by pouring on a plate of pure silver strong sulphuric acid and adding a few drops of strong nitric acid. At first there was a slight action, bubbles of gas being liberated. In a day or two the whole of the sulphuric acid acquired a deep purple tint, probably due to the formation of some oxide of nitrogen. After a lapse of two to three weeks the purple tint sinks toward the silver and a slight brown tint can be seen on the surface. The layer above the silver being colorless, about this period long crystals form, which redissolve, and the liquid becomes colorless. In the course of a few days brilliant specks are seen, which develop into perfect crystals of a regular octahedral shape. The crystals shown had taken over six months in growing.

ARTIFICIAL INFLATION OF THE LUNGS.

DR. GADBURY, of Yazoo City, Miss., employs a very simple and inexpensive apparatus for artificial inflation of the lungs—a method of treatment which, however valuable, has been greatly restricted in practice on account of the bulk and expensiveness of Waldenburg's apparatus. It consists merely of a Richardson hand-ball and bulb atomizer, in which a mouth-piece has been inserted in place of the spray tubes. The method of its employment is as follows: the patient, having dilated his lungs to the fullest extent, immediately places the tube of the compressor between his lips, closes the nasal passages with one hand, and works the compressor rapidly with the other hand. A few squeezes pump an intermittent current of compressed air into the lungs; as soon as the distention becomes unpleasant, or the need of an expiratory movement is felt, the instrument is withdrawn, to be replaced and re-employed in the same manner a few moments subsequently, the operation being repeated four or five times in succession. In a healthy subject the operation is painless and may be prolonged for a minute or more, but to a person with diseased lungs it is at first disagreeable though not painful. The patient can at first force in but little air, but practice soon enables him to pump it in more freely and for a longer period each day. After frequent use it affords great comfort to those who suffer from a feeling of suffocation and have diminished capacity of the lungs. Dr. Gadbury gives brief histories of a number of cases in which the apparatus was employed with great benefit. He claims that the fresh air thus forced into the lungs expands unused capillary tubes and air-cells, displaces the residual air and noxious gases, excites cough and expectoration, removing morbid secretions at once, and obviating the necessity for expectorant medicines, oxygenates the blood, promotes absorption, relieves dyspnœa, gives impetus to the pulmonary circulation, reduces temperature in fever, and desiccates the fluids in the air passages. He expects beneficial effects from inflation by this method in croup, diphtheria, bronchitis, asthma, tuberculosis, whooping cough, asphyxia, chloroform poisoning, foreign bodies in the air passages, and many other obstructive lesions of the pulmonary organs. Vapors and gases may also be introduced into these organs by means of this method.

Dr. J. Solis Cohen writes that he has given this plan a trial during the past year. He has found that it cannot be employed safely in all cases in which Waldenburg's apparatus can be employed with advantage, but that it has a sufficiently wide range of utility. In patients liable to hæmoptysis or other hemorrhages, and in certain cardiac and visceral disorders, the intra-thoracic compression, if left to the patient, is apt to be too powerfully exercised, and thus to be absolutely detrimental. He believes that it is seldom safe to use compressed air with a pressure exceeding from one-sixtieth to one thirtieth of an atmosphere, and quite delicate handling of the ball-compressor is requisite to keep within this limit, while the size of the compressor prevents access of air in large volume, or at constant pressure. He has found the Gadbury particularly useful as a mechanical expectorant.—*St. Louis Courier of Medicine.*

NEW STUDIES INTO THE NATURE OF DIPHTHERIA.

UNDER the direction of the National Board of Health certain experiments have been recently performed by Drs. H. C. Wood and H. F. Formad with the object of discovering the nature of the diphtheritic poison. These experiments were made for the most part upon rabbits, and were intended primarily to discover whether diphtheria could be induced in those or other lower animals. This particular point was quite well settled in the negative some time ago by Curtis and Satterthwaite, whose investigations were far more extended than those which are now presented. Drs. Wood and Formad have, however, given some valuable corroborative evidence, and have added other facts which are very suggestive and which really bring us somewhat nearer a true knowledge of the pathology of diphtheria.

The first series of experiments was made by inoculating bits of fresh diphtheritic membrane in the mouth and thigh of thirty two animals, eighteen being rabbits, the remainder cats, dogs, and a goat. Six of these animals, all being rabbits, died within about two weeks or less from the time of inoculation. *Post-mortem* examination discovered evidences of tuberculosis in every instance. In only one case was there any tracheal false membrane, and in this the deposit may have been due simply to a catarrhal inflammation. Micrococci were found in the blood. In no case did inoculation by the mouth cause any local or general symptoms, a fact which corresponds with the observation of Curtis and Satterthwaite, that inoculations in the cornea were entirely ineffective. The inoculations in the thigh seemed to result in the development of small, cheesy lumps. These either became absorbed, or they infected the system and caused death by tuberculosis. The rabbits, then, it is concluded, may either die very soon after inoculation of diphtheritic membrane, by absorption of a non-specific septic poison, or they may die a week or two later from a tuberculosis due to absorption of cheesy products. Most of the animals experimented on by Curtis and Satterthwaite died from the former cause, perhaps because they used larger pieces of membrane and inoculated more deeply.

It was shown by subsequent experiments that the tuberculosis was not due to anything specific in the membrane, for that disease followed the inoculation of bits of wood, glass, and wire.

So far not much more had been discovered than was already known.

The next series of experiments was made to determine the accuracy of Trendelenburg's assertion that the introduction of pseudo-membrane into the trachea produces diphtheria. Dried diphtheritic membrane was introduced into the trachea of four rabbits. One of these died in five days. The *post-mortem* showed a delicate pseudo-membrane in the trachea. It was 1 mm. thick in some parts, was infested with micrococci, and showed the usual structure of natural and traumatic pseudo-membrane. The internal organs were tuberculous, but there were no bacteria in the blood. The experiments, as far as they went, confirm the statements of Trendelenburg, but they indicate very little.

A study was then made of the effects of ammonia in producing pseudo-membranous trachitis. This substance was injected into the trachea of four rabbits, a cat, and a dog. All the animals except the dog died, death generally coming on in two or three days. False membrane was observed in the trachea of all six animals, and tubercles were also uniformly present in the internal organs. Furthermore, contrary to the statements of Oertel, bacteria and micrococci were in every instance found in the traumatic false membranes. The experiments seemed to show that diphtheritic membrane placed in the trachea will produce a fatal pseudo-membranous trachitis, although the same membrane inoculated in the thigh will not cause death, except indirectly, by exciting caseous foci and a resulting tuberculosis. This point, as stated by the experimenters, needs a further study.

A fifth set of experiments showed that other foreign bodies, such as slough, inflammatory products, and pus, will also produce a pseudo-membranous trachitis. So that the conclusion is almost certain that such trachitis is not a specific process, but is only an intense inflammation such as any highly irritant body may excite.

As a general conclusion, then, it is stated that the contagious material of diphtheria is really of the nature of a septic poison which is also locally very irritant to the mucous membranes; so that when brought in contact with the fauces and nose it produces an intense croupous inflammation simply by its local action and without any absorption. But further, though it may sometimes thus act locally and directly, it may also bring on the angina by being first absorbed, then acting locally by being carried in the blood to the mucous membrane of the throat. Under this theory, again, it is possible that the poison may cause a purely local angina, no absorption occurring; or, on the other hand, a simple local non-specific trachitis may end in adynamic diphtheria in consequence of absorption of septic material.

In regard to the relation of bacteria to the disease, it is stated that it seems altogether improbable that they have any connection with it whatever. There is, however, the possibility that the bacteria may act upon the exudations of the trachea as the yeast plant acts upon sugar, and cause the production of a septic poison which differs from that of ordinary putrefaction, and bears such relations to the system as, when absorbed, to cause the systemic symptoms of diphtheria.

These views in regard to the nature of the diphtheria poison have a good deal of the hypothetical about them, and are, indeed, only put forward tentatively by their authors. The experiments of Dr. Wood and Dr. Formad are very instructive, but perhaps in no direction more than in showing where further investigation is needed. It is to be hoped that the National Board of Health, whose bulletins have heretofore been somewhat meager in scientific matter, will see that the present work is continued.—*Medical Record.*

BAD ODOR FROM THE FEET.

GEORGE THIN, M.D., in an article on the above subject, published in the *British Medical Journal*, says:

Profuse sweating of the palms and soles is not uncommon, but, in order to produce the specific odor to which I refer, something more than mere profuse sweating is required. The excessive perspiration, when confined by stockings and boots, macerates the epidermis, and, if the person stand or walk much, the skin of the heels becomes tender. This tenderness is accompanied by redness, slight blistering, or, more decided, localized eczema. In damp, relaxing weather, perspiration is increased; and we have thus two causes of aggravation, each potent, but, both together, very powerful—moist warm weather and prolonged pressure by walking or standing.

It has been pointed out by Hebra that the evil smell is not in the sweat itself, but in the coverings of the feet, a fact which it is easy to verify.

The patient who has afforded me the opportunity of investigating the cause of the smell is a young woman, aged twenty-two, who has suffered from evil-smelling feet, with soreness of the heels, for several years. Her hands are usually moist, or even wet, but are always odorless. The smell from the feet is not constant, disappearing in dry, bracing weather, and reappearing when the weather is moist and depressing.

The experiment I made was to subject the soles of the stockings and boots to the action of an antiseptic solution. The success was complete, the odor being entirely banished. The antiseptic precautions having been soon neglected, the smell returned, and I took the opportunity of investigating its cause more minutely.

The sole of the stocking, a few hours after it was put on, was found to be quite wet; and a stocking, if worn for a whole day, was so extremely offensive that, when held close to the nostrils, its overpowering fetor was comparable to that of putrid blood. The inside of the boot was equally wet and offensive; but at the very time that the stocking and boot smelt so strongly, the heel itself, exuding moisture profusely, had no disagreeable odor. The sole of the heel was reddened and tender, and macerated around the edge, like a washerwoman's palm.

The reaction of the moisture in the stocking and in the sole of the boot was alkaline, that of the moisture exuding from the skin of the sole of the heel faintly alkaline, while that of the perspiration of other parts of the body was acid.

The fluid from the sole of the heel was thus shown to be not pure sweat, the faintly alkaline reaction being doubtless due to the serous discharge accompanying the eczema set up by the local hyperidrosis.

The fluid in the sole of the stocking was found to be teeming with bacteria forms, the nature and development of which I have carefully investigated. These investigations have produced results of some scientific interest, which I have communicated to the Royal Society. The rapid development of bacteria in the fluid which exudes from the soles is doubtless favored by the alkaline reaction produced by the mixture of serous exudation with the sweat.

The treatment instituted in this case is as simple as it has been effective. The stockings are changed twice daily, and the stocking-feet are placed some hours in a jar containing a saturated solution of boracic acid. They are then dried, and are fit for wear again if it be desired. The boracic acid effectually destroys the smell. But to kill the bacteria in the stocking is not enough. The leather in the bottom of the boot is wet and sodden, and smells as vilely as the stocking. This difficulty is got over by the use of cork soles. I directed my patient to get half a dozen, which she finds sufficient. A pair must only be worn one day unchanged; at night they are placed in the boracic jar, and are put aside the next day to dry. If these directions be accurately carried out the evil smell is perfectly destroyed.

The boracic acid solution is an excellent application to the painful skin in these cases. When the tender skin of the soles is washed with it, a sensation of coolness succeeds the feeling of heat and tension, which are the usual accompaniments of the eczematous condition associated with the smell, and the skin becomes harder and loses its abnormal redness.

The bacteric fluid would seem to act as a direct irritant to the skin. My patient assures me that, if she wears stockings which have been dried without being disinfected, irritation is speedily felt; and that the cork soles, if worn a second day without having been purified, act in a similar way.

ON THE MICROSCOPIC CRYSTALS CONTAINED IN PLANTS.

By W. K. HIGLEY.

IT has been the custom to call all crystals that occur in plants, whether in the cell contents, the cell-wall, or even the non-microscopic crystals that are found in the outer portions of plants, by the common name "raphides," no matter what the form may be. And while giving this general name to their form, a much more general chemical composition was given, viz.: oxalate of lime; and for a long time they were all supposed to have had this composition, and even up to the present day many writers have considered them thus. The decision of some seems to have been based on the analysis of the inorganic matter of one crystal-bearing plant, which proved to have the above composition, and in drawing their conclusions they considered that all crystals of apparently the same crystalline form, were of the same composition. But it is difficult to tell, at all times, the exact crystalline form, as different forms sometimes resemble each other very much. And as the form may vary, so may the chemical composition. Crystals of some form seem to be nearly or quite-universal; on close examination they may be found in some part or parts of the majority of plants. In some plants they are only found in a certain position and of one form, while in others they may occupy several localities of the plant, and have as many forms. But the position and form often vary so much that it has been recommended by some authorities that they be made a family, and in some cases a generic distinction in the study of systematic botany.

Prof. Geo. Gulliver, while making dissections under the microscope for the purpose of comparing the relations between the structure of plants and animals, made note of every case, in the examination of plants where raphides or other crystals occurred, and he says: "It was not before a large accumulation of my notes had been examined that crystals were thought of in this point of view; for they had not even been particularly looked after, and were merely noted whenever seen, long before their significance as characters were suspected. But when every one of these notes on raphides had been picked out, it was very unexpectedly discovered that the plants in which they occurred would sometimes come under certain orderly arrangements. Thus not a single species belonging to the order Onagraceæ or Galiaceæ was without a note of raphides, while in no single instance were these acicular crystals noted in the next allied orders." A converse example is then given. He then proves by more extended experiments that raphis-bearing is essential throughout the lives of certain species. By this and other experiments that I might mention it is shown that the form and position of microscopical crystals in plants may be used as a distinctive character between orders especially, and perhaps, to a certain extent, between genera and species (?). Plant crystals as a character would only be of benefit to the botanist who had at hand a microscope that magnified at least a hundred and twenty-five diameters. Hence the objection to making them a means of identifying plants in our works on systematic botany.

As to the history of crystals, Lindley states that they were first seen by Rafn, who found them in the milky juice of some species of the family Euphorbiaceæ, and that they were afterward seen by Jurine in the leaves of *Leucoium vernum* and elsewhere.

Edwin Lankester, M.D., writing on raphides, credits Malpighi with the discovery of crystals in plants, who found them in a species of Opuntia, and he says, further, that they were afterward described by Rafn as occurring in the milky juice (latex) of some plants belonging to the family Euphorbiaceæ, and that Jurine soon after found them in the leaves of *Leucoium vernum* as stated by Lindley.

Raspail seems to have been the first person who studied crystals with their chemistry in view, at least he was probably the first to demonstrate that some of the crystals were composed of calcic oxalate.

John Quekett, in a paper written in or about the year 1852, also gives the credit of the discovery to Malpighi, and says that they were subsequently described by Jurine and Raspail, as stated above.

Prof. Gulliver says that the raphides so early mentioned by Rafn in the Euphorbiaceæ were only the starch-rods which he (Gulliver) described as having found in the latex of the British Spurges.

Crystals should be divided into (at least) three classes, and these seem to cover all the ground that was formerly covered by the name "Raphides." They are as follows:

1. Raphides.
2. Sphæraphides.
3. Crystal prisms.

1. *Raphides.*—The term raphid is from the Greek *raphis*, a needle, and was formerly applied by De Candolle to crystals resembling a needle in form.

Professor Gulliver gives the following definition of the term:

"These are slender needle like crystals with rounded, smooth shafts, vanishing at each end to a point, from about ten to fifty or more lying parallel together so as to form a bundle, which partially fills a cell or intercellular space."

I have never been able to find over thirty in one cell, and generally from five to twenty-five. The cells which contain them are generally elongate, or quite oval. To obtain these crystals in a bundle and still have a thin section fit for microscopical work, a steady hand and great care are required, as they are easily disturbed, when they will be seen scattered in every direction. Often on slight pressure they

are seen to escape, one by one, quickly from one or both ends of the cell. When this occurs they are then known as "Biforines." The bundle of crystals is very loose and might be compared to a bundle of needles.

The genus *Trillium* affords a good example for the investigation of these crystals, and still better the species of the family *Araceæ*, with one exception, which will be mentioned soon. In this family the raphides are found in great abundance and are about the largest that I have seen. As the plants of this order are very common, any one may examine them at pleasure. They may be found in any part, but are the best seen in the stem.

2. *Sphæraphides.*—This word is from the Greek *sphaira*, a sphere or globe, and *raphis*, a needle or pin. "They are more or less rounded forms made up of a congeries of crystals, many of which are prisms, often acicular." As they often have points extending in all directions from the main body of the crystal, they appear rough and frequently stellate; they are generally found regularly placed, one embedded in the substance of each cell. A collection of cells containing these crystals is known as a "sphæraphid tissue."

The flower parts of the geranium serve as a good field for observing them. These crystals are very common and are found in connection with raphides in the family Vitaceæ. But the best place to examine them is in the family Cactaceæ. These crystals as well as the next class were formerly known, incorrectly, under the common name "Raphides."

3. *Crystal prisms.*—These are "acicular forms with well marked faces and angles both on the shafts and tips." They are found embedded in the tissue of the plant, and are never seen in bundles or loosely packed together, or single in a cell or intercellular passage. I have found as many as five of these crystals embedded close together in certain tissues, but generally only one. They vary much in size, but are generally much larger than raphides, from which they may be easily distinguished. The family Compositæ furnish about the best field for the examination of this class of crystals, but they are much less common than the other forms of crystals.

My own observations and experiments have been, at present, mostly confined to the natural orders Araceæ, Vitaceæ, and Compositæ. I examined the first two orders especially, as they abounded in crystals, and this gave me a better opportunity to examine into their chemical composition with more sure and satisfactory results.

In examining each specimen for the composition of the crystals, I first made the test under the microscope as far as possible, and in the case of inorganic crystals incinerated the substance and analyzed the residue. Of course from this analysis it is not possible to state the exact composition of the crystals, whether they are, for example, acid or neutral salts; but we are able to state with certainty what the elements are that enter into the crystal. And at times and under certain conditions, and also by analogy, the exact composition may be ascertained; for example, if on examining the tissues of a plant octahedrons are found, and if under the microscope they do not effervesce with acetic acid, but do with stronger acids, and if after incineration we find on analysis calcium and carbonic acid, we may conclude with certainty that these crystals are composed of calcic oxalate. However, other acids than the one just mentioned do occur, as phosphoric and carbonic acids; the former I tested for under the microscope in the following manner: obtaining as large a field as possible of the crystals, I added a drop of hydrochloric acid and heated the slide slightly and then added a small amount of molybdate of ammonia; heating the slide again and allowing it to stand for some time, I placed it under the microscope, when, if any phosphoric acid was present the characteristic crystals of phospho-molybdate of ammonia would appear. These crystals are stellate forms consisting of four or six points, and have a yellow color. *This test requires care, as too much heat seems to dispel the crystals.*

The latter (carbonic) acid I detected in the usual manner with acetic acid.

The three acids mentioned above are the only ones that I found. Dr. Gray, in his "Structural and Physiological Botany," page 60, reports sulphuric acid.

The tests applied for the base were the same as those given in Douglas and Prescott's "Qualitative Analysis," but the only base found was calcium. The methods of testing given above were followed in nearly all cases. Where there is any change it will be mentioned in its proper place.

I will now give the results of my own work, commencing with the order Araceæ; in this order the raphides are abundant and large, and the cells that contain them are much elongated. The bundles contained from ten to twenty-eight crystals. The number was noted in twenty specimens and the average, twenty-five, taken from the results. Raphides were found in all parts of the plant *Arisæma triphyllum*; they varied some in size, but were, on the average, about one hundredth of an inch long and one-thousandth in diameter. The raphis-cells were very large and elongated, and easily distinguished from the surrounding cells.

Dracontium, another species of the same genus as the above, showed no material difference in the position, size, and number of the crystals from the first species.

In *Symplocarpus fœtidus*, or skunk's cabbage, the crystals were as common as in Arisæma, but were, on the whole, somewhat larger, and were found, as in the above species, throughout the plant. The raphis-cells of this plant were about $\frac{1}{50}$th of an inch in length and $\frac{1}{1000}$ in diameter. Some of the crystals appeared to be biforines, which I did not observe to be the case in any other species of this order. Thus if the odor of this plant can be overcome, it furnishes a good field for work upon this subject.

In *Acorus calamus*, or sweet flag, I was not able to find a single raphid, and as far as I am able to find articles upon the crystals of this family, none have ever been reported, but time and again students have been disappointed in not finding them. This genus is thus marked off from the rest of this family, although agreeing with the family characters perfectly in other particulars. Dr. Gray, in his systematic arrangement of plants, places this genus in the family Araceæ, but Lindley, on account of there being no raphides, and as the general characters of the plant would not permit of its being placed in any other family, places it in a family by itself, calling it Acoraceæ. This genus contains but few crystals of any sort. On examining a number of specimens I found only a few crystal prisms, which effervesced and dissolved with hydrochloric acid and were probably oxalate of lime. With the exception of the genus Acorus the crystals mentioned in this family showed with certainty that they were composed of phosphate of lime when the chemical tests were applied both under the microscope and also to the incinerated residue.

I shall now take up the species of the family Vitaceæ, and in these a wider view of crystals will be presented.

This family gives us a good field for the examination of both raphides and sphæraphides in the same plants. In all the species that I have examined the raphides were the most abundant in the leaves, with their appendages, the petiole, and the epidermis of the stem in young plants, while the sphæraphides were more common in the old stems and berry, but were also found, though rarely, in the other parts mentioned for raphides. Crystals in the grape have been known for a long time. In the common cultivated grape, raphides are abundant, but the largest are only found in the leaf and petiole, and at times much smaller ones may be looked after in the fruit. These crystals, whenever found, gave the test for phosphoric acid and lime. In the pulp of the berry sphæraphides are abundant; those of the fruit stalks were about one-thousandth of an inch in diameter. When a collection of these is met with they form a beautiful field, which I think is only surpassed in beauty by the sphæraphid tissue in the testa of the elm. These crystals would not answer to any of the chemical tests except those for calcium, so that I have reason to believe that the base was combined with some organic acid, perhaps tartaric.

Vitis æstivalis and *V. cordifolia* abounded in both sorts of crystals, but neither were as large as in the common grape. In *Ampelopsis quinquefolia* I found raphides, but they were often free—that is, they were not in a close bundle. The sphæraphid tissue is very fine in this species. Each crystal seems to form a nucleus to a single cell. The cells are placed very regularly and symmetrical in form. The blackberries contained raphides in more abundance and of a larger form than those of the grape fruits, but the largest were in the leaves and petioles of the younger shoots. The sphæraphides were not as large as those of the grape. As in the genus Vitis, the crystals of this species, except those mentioned last, seemed to contain lime as a base and phosphoric acid.

In this family all the crystals contained in the fruit, except the raphides, gave the tests for lime, but failed to give the tests for the common acids, so that I think it probable that the base was in combination with some organic acid. I expected to find in this family more acicular crystals, but in this I was disappointed.

The next order that I shall report upon, as is well known, is the largest natural order, and is represented by a number of hundred species, it being universal. This family, the Compositæ, is well represented in the Northern States. Raphides are not as common in this family as in the other two, Araceæ and Vitaceæ, but forms of all three classes do occur. I have only found the needle-shaped crystals in the ovary or fruit, and sometimes in the receptacle and involucre. In some species minute cubical crystals occur which dissolve with effervescence in acetic acid. Globular masses of crystals known as inuline are quite common. I did not find the raphides in bundles except in one case, *Achillea millifolium*, which contained in the receptacle, on the average, about twenty raphides in each bundle; in all other cases when raphides were found they were single, which was perhaps due to some disturbance.

In *Inula helenium* I could find no crystals except the globular aggregate known as inuline. This substance is an organic compound having the composition $C_6H_{10}O_5$. Miller says that this is a variety of starch, insoluble in alcohol, but soluble in hot water, and by boiling with dilute acids it is converted first into dextrine and then into pure lævulose. It forms an insoluble precipitate when its solution is mixed with one of acetate of lead and ammonia is added. I did not attempt to extract it from the root, as that is quite a difficult operation to perform. The crystals appear like a globular mass, with fissures radiating from the center outward; iodine, when applied to the well-cleaned section, gives with inuline a distinct yellow color. This statement is in direct opposition to that made by Fluckiger and Hanbury (see Pharmacographia under elecampane). The only part of the plant that I had was the root, it being too early for the stem, leaves, etc., so that I am not able to state what might be found in the other parts.

Taraxacum dens-leonis also contains inuline, but in much smaller amount than the last, and also a few sphæraphides, which seem to have no particular location, as they may be found, on close examination, in almost any part of the plant, although rare. They were too small and too few in number to obtain any definite chemical tests with them. Also raphides were present, but only in small numbers and not in bundles.

Cichorum intybus contains inuline, but it is in still smaller amounts than in the last.

I also found inuline in the root of *Cirsum arvense*, or Canada thistle, in which plant raphides are formed in the flower receptacle and also in the parts of flower, also some other crystals, which seemed to have four faces tapering to a point at each end (crystal prisms). The number of faces were probably double this. These crystals were soluble, with effervescence in hydrochloric and not in acetic acid. The raphides gave the chemical test for phosphate.

In *Cirsium muticum*, or swamp thistle, the crystals of inuline were very small and indistinct. The raphides were found the same as in the last species, though more numerous. The crystal prisms I was not able to find at all, the reason perhaps is that I had only a young plant, while of the Canada thistle I had a fall or late specimen. *Cirsium lanceolatum* gave the same results as *C. arvense.*

In *Cynthia virginica*, raphides of small size but no inuline were found. There were also a few cubical crystals in the lower part of the stem and in the flower receptacle, which gave answer to the test for carbonic acid with acetic acid, but the raphides proved to be phosphate. The cubical crystals were about the two-thousandth of an inch in diameter.

Senecio aureus and *S. balsamita** contained acicular crystals, which, upon chemical examination, gave evidence of oxalate of lime. In this genus I was not able to find any raphides at all, nor any inuline. A few crystals were present, but, on account of their small size and number, I was neither able to determine their form nor chemical nature.

Lappa major, or common burdock, contained in the flower receptable and dried fruit, minute cubical crystals, which gave the tests for carbonate of lime. No raphides or acicular crystals of any sort were present.

Tanacetum vulgare contained both cubical and acicular crystals, the latter in the leaves and petiole and the former in the flower parts and upper part of the stem; but oxalate and carbonate of lime seemed to be present.

The raphides of this order seem to be rarer in the division or sub-order Liguliflorœ, while the acicular crystals or crystal prisms were only found in the sub-order Tubuliflorœ. Inuline is common to both sub-orders.

* A variety of *S. aureus.*

It will be seen, on reference to my work, that the raphides seemed to be composed of phosphate of lime, the acicular or crystal prisms, of oxalate, and the cubical crystals, of carbonate of the same, while the sphæraphides seemed to be the same base combined with different acids according to their locality.

It will be remembered that in the first part of this paper I mentioned the fact that crystals of some form were nearly if not quite universal, and, as some slight evidence of this, I have compiled with care a list of all the families in which crystals have been reported. This is the beginning of a more complete list of the genera and species which I hope soon to have ready for publication, which will be classified according to the kind of crystals that the species may contain.

The following is the list of families:

CRYPTOGAMIA.

* Filices,	Musci,
Equisetaceæ,	Algæ,
Hepaticæ,	*Fungi.*
Characeæ,	

PHÆNOGAMIA.

EXOGENÆ.

Araliaceæ,	Juglandaceæ,
Aurantiaceæ,	Leguminoseæ,
Balsaminaceæ,	Linaceæ,
Berberidaceæ,	Melastomaceæ,
Cactaceæ,	Nyctaginaceæ,
Camelliaceæ,	*Oleaceæ,*
Caprifoliaceæ,	*Onagraceæ,*
Caryophyllaceæ,	Orobanchaceæ,
Chenopodiaceæ,	Oxalidaceæ,
Cinchonaceæ,	Passifloraceæ,
Compositæ,	Phytolaccaceæ,
Coniferæ,	Polygonaceæ,
Crassulaceæ,	Pittosporaceæ,
Cruciferæ,	*Rubiaceæ,*
Cycadaceæ,	Saxifragaceæ,
Droseraceæ,	Scrophulariaceæ (Gelsemineæ),
Elæagnaceæ,	Tetragonieæ,
Euphorbiaceæ,	Tiliaceæ,
Ficoideæ,	Urticaceæ,
Fumariaceæ,	Valerianaceæ,
Galacineæ,	*Vitaceæ,*
Geraniaceæ,	Zygophyllaceæ.
Galiaceæ,	
Halorageæ,	

ENDOGENÆ.

Amaryllidaceæ,	*Linaceæ,*
Araceæ,	Marantaceæ,
Bromeliaceæ,	Melanthaceæ,
Burmanniaceæ,	Musaceæ,
Butomaceæ,	*Orchidaceæ,*
Cyperaceæ,	Orontiaceæ,
Dioscoreaceæ,	Pandanaceæ,
† *Gramineæ,*	Pontederiaceæ,
Hæmodoraceæ,	Smilacaceæ,
Hypoxidaceæ,	Typhaceæ,
Iridaceæ,	Xyridaceæ,
Juncaceæ,	Zingiberaceæ.
Liliaceæ,	

The names that are in italics indicate the families in which I have seen and studied the crystals, but only in a few cases their chemical composition.

Some of these, as the Onagraceæ and Orchidaceæ, contain large and beautiful crystals. In the vanilla bean, which is a fruit belonging to a species of the latter family, T. F. Meyer, of the university class of '78, has reported and made drawings of the crystals. He states that they are composed of the active principle of the bean and belong to the second class or crystal prisms.

It is often supposed that minute substances have no particular use, and so it may be thought of these minute crystalline bodies; but generally anything that occurs in such abundance and so regularly has some use in the economy of either the animal or vegetable kingdom. On the use of the crystals, Prof. Gulliver says: "Although the precise use of crystals in the vegetable economy may be obscure, it is plain that whatever is constant in the plant must be important, and by no means necessarily of little importance because of such obscurity." Taking, for example, the Cactus family, which abounds in large crystals, some specimens of which have been reported to contain so many of these minute inorganic bodies that it was almost impossible to move the plant without breaking it, and when moved it was necessary to pack it in cotton with great care, as if it were the finest jewelry. A case like this is seldom met with, but as the occurrence of crystals is so constant a feature of this family, they must be of some use, which is, as yet, beyond the reach of man's power to perceive, and it would seem ridiculous to say that they have no use as some prominent scientific gentlemen claim.

But such crystals may be of use to man, perhaps in two ways; first, when contained in some medicine.

It is well known that the disease called "rickets" is treated, or at least has been, with sarsaparilla; now the plant itself contains a large number of crystals which are composed of phosphate of lime. Query—Why may not this plant, in connection with its tonic effects, also furnish some of the needed phosphate to strengthen the bones?

Second, they may be of use to man when contained in decaying leaves or plants, thus acting as a fertilizer.

Again, crystals are sometimes used by the merchant as a test for the genuineness of a drug. The quality of rhubarb is often tested by its grittiness, which is due to inorganic crystals, and rhubarb should contain a high per cent. of inorganic matter.

Other uses might be enumerated and given in this list, and perhaps some of them are of more importance than those mentioned, but sufficient has been said to show that they are probably of some practical value to man. It is hoped that this article will induce other investigators to take up this subject, and find, if possible, their exact use in the economy of the plant.

The time is probably not far distant when we will know more about microscopical crystals in plants, and for that time we must all wait, each investigator endeavoring to do his best.

* In this family I have seen crystals but once, and these were contained in *Phegopteris hexagonoptera.*

† The crystals of this family were shown to me by a fellow-student in the University, Ann Arbor, Mich.

BIBLIOGRAPHY.

Quar. Journ. of Micros., I., old ser., 20; III., new ser., 243; IV., new ser., 207, 208, 209, 234, 208; V., new ser., 49, 83, 140, 220, 279; VI., old ser., 120; IX., new ser., 232; XIII., new ser., 290, 216, 324, 294, 439; XIV., new ser., 108, 211; XII., new ser., 288.

Ann. and Mag. of Nat. Hist., XI., 3d ser., 13; XII., 3d ser., 226, 446, 288, 365; XIII., 3d ser., 41, 119, 212, 292, 406, 508; XIV., 3d ser., 53, 250; XV., 3d ser., 38, 211, 380, 456; XVI., 3d ser., 115, 331.

Sachs "Text Book of Botany."

Lindley's Introduction to Botany.

Gray's Structural and Systematic Botany.

Flückiger and Handbury—Pharmacographia.

Miller's Organic Chemistry.—*American Naturalist.*

EXISTENCE OF ZINC IN ALL PRIMARY ROCKS, AND IN SEA WATERS OF ALL AGES.

By L. DIEULAFAIT.

ZINC is found in all rocks of the primary formation. In the greater number of the 714 specimens examined it could be detected in 50 grammes, and in all cases in 100 grammes of the rock. It could also be detected in 50 grammes of each of 155 specimens of non-fossiliferous, lustrous palæozoic schists, and in the same quantity of 579 specimens from the lower fossiliferous deposits (silurian, devonian, carboniferous, and permian). In the case of sulphureted schists, especially if containing coal, zinc could almost always be detected in 5 grammes of the rock. It was likewise found in 50 c.c. of the last mother-liquors of the French salt marshes. Taking into account only the quantity remaining in solution in these mother-liquors the waters of the Mediterranean contain at least 0·002 gramme zinc per cubic meter. The muds of salt marshes, of old estuaries, and of estuaries still communicating with the sea, contain the same metal in such quantity that it can be readily detected in 50 grammes. It can also be detected in 50 grammes, indeed frequently in a much smaller quantity of saline deposits, which the author considers to be of estuarine origin, and the specimens of which, 128 in number, were mainly taken from the upper trias, and in a similar quantity of dolomitic rocks.

Blende is found in primary rocks, but especially at the point of contact of these with sedimentary deposits; the carbonate usually occurs in the latter. The deposits of Belgium and of Vieille Montagne are in the carboniferous formation, those of Silesia are in the trias. Now zinc is readily detected in carboniferous schists and in saline deposits of the triassic period. Probably the zinc compounds have been extracted from the primary rocks by the action of sea water, then concentrated in estuarine deposits, afterwards redissolved by other water, and transported in a more or less pure condition to the places where they are now found. If the water contained no dissolved oxygen the zinc would be deposited as sulphide, if it were freely exposed to the air, as carbonate.

The author has, up to the present time, proved the existence in the primary rocks of lithium, strontium, barium, zinc, manganese, and copper, and has shown that these metals are concentrated in muddy deposits, which are always sulphureted. When water containing dissolved oxygen or carbonic anhydride acts on the deposits, these substances undergo a series of changes terminating in the formation of the most stable compound, which will be different in different cases: for strontium, and especially barium, the sulphate; for manganese, the dioxide; for lead, the sulphide; for zinc and copper, the sulphide or carbonate, according to the quantity of air dissolved. These transformations will not all take place with the same rapidity, consequently the different minerals will be separated and deposited at different points of the water's course. But the barium tends only to form the sulphate. The formation of this compound will therefore be gradual and continuous; it will be deposited at all points in the course of the water, consequently in company with all the various minerals, and also filling the gaps between the different metalliferous deposits, as we actually find it in lodes. It follows that all minerals having a barytic gangue have been formed from the primary rocks by one series of changes; hence they contain traces of rare metals, such as thallium, indium, and gallium, which also exist in those rocks. According to this view new metals should be sought for, not in mineral deposits having a barytic gangue, but in such rocks as the cupriferous schists of Mansfeld, Russia, and Bolivia, which have undergone but little modification.—*Compt. Rend.*

IRON IN THE DUST SHOWERS OF SICILY AND ITALY.

By TACCHINI.

THE dust showers which from time to time have fallen in Sicily and Italy contain spherical grains of meteoric iron; similar grains are found in the sand of the Sahara. In all probability the sand rains of Italy and Sicily are purely terrestrial phenomena, the sand being transported from the desert by cyclones.—*Compt. Rend.*

PROFESSOR BENJAMIN PEIRCE.

PROFESSOR BENJAMIN PEIRCE, LL.D., F.R.S., Perkins Professor of Astronomy and Mathematics at Harvard University, died at his home in Cambridge, Oct. 6, in the seventy-second year of his age, and the fiftieth of his connection with the University. His father and mother were both distinguished for their acuteness of mind, and his instructor, Nathaniel Bowditch predicted that the boy Peirce would be one of the first mathematicians of his day—a prediction fully realized. In 1831, two years after graduation at Harvard College, he was appointed mathematical tutor; in 1833, professor; and in 1842 he was appointed to the chair he filled and honored until his death. He found it consistent with his devotion to science to do much work in connection with other institutions than Harvard during his professorship. Among these services, in 1849 he undertook the revision of the American Ephemeris and Nautical Almanac, for which he prepared his valuable lunar tables. In 1855 he was one of the commission to organize the Dudley Observatory. From 1867 to 1874 he was in charge of the United States Coast Survey, and rendered great service to the country and to science by recruiting the languishing financial strength of that service and impressing upon Congress the duty of effectually reorganizing and pushing forward the work so much retarded by the civil war. He was one of the original members of the National Academy. He threw all his influence into the organization and successful development of the American Association, which he always held should be free from class distinctions, and to which he would never be elected in the higher class of fellows but was a member only. He contributed very largely to make the American Academy of Boston what it is, and throughout the whole of the scientific literature of the past fifty years Peirce's name frequently occurs as a contributor upon mathematical and physical topics. In his own department of the University he thoroughly impressed the concise methods of thought so effectually used in his greater works. The teaching at Harvard is based upon his methods and notation, and these methods are models of perspicuity and elegance. In physical astronomy perhaps his greatest works were in connection with the planetary theory, his analysis of the Saturnian system, his researches regarding the lunar theory, and the profound criticism of the discovery of Neptune following the investigations of Adams and of Leverrier. As a mathematician, his work on Analytical Mechanics, his treatise on Curves, Functions, and Forces, and his memoir on Linear Associative Algebra all evince extraordinary originality and genius. Many of his detached papers, relating to the theory of observing, and the solution of special problems, show an appreciation of the needs in applied mathematics which perhaps has not been exhibited by the same order of genius since the death of his friend and admirer, Gauss. His originality was fostered by his habit of examining a new mathematical question for himself, and only referring to the work of other geometers after he had first fairly exerted his own powers of analysis.

His genius was early recognized abroad, and elections to the Royal Societies of London, Edinburgh, and Göttingen and to various continental societies were awarded him. The versatility and breadth of his mind is partly shown by the scope of his papers; but to those who came in daily contact with him he showed such a penetrating discernment of the conditions of a problem, he made such sagacious suggestions regarding the inferences to be drawn from the data before him, he showed such a wonderful power of generalization, that the papers he has given to the world only seem to indicate the quality of work his mind had constantly before it, and to afford no idea of the multitudinous problems he had been interested in and discarded as soon as the solution became evident to himself. He habitually ascribed to his listener a power of assimilation which the listener rarely possessed. He assumed his readers could follow wherever he led; and this made his lectures hard to follow, his books brief, difficult, and comprehensive, and his best work only when his listeners were students trained in his methods who had already attained some skill as mathematicians. He was personally magnetic in his presence. His pupils loved and revered him, and to the young man he always lent a helping hand in science. He inspired in them a love of truth for its own sake. His own faith in Christianity had the simplicity of a child's; and whatever radiance could emanate from a character which combined the greatest intellectual attainment with the highest moral worth, that radiance cast its light upon those who were in his presence. His works are already scarce and some of them hardly obtainable; notably the second volume of his "Curves, Functions, and Forces," and his memoir on "Linear Associative Algebra." It is much to be desired that the manuscripts he has left be completed so far as possible and made accessible; and this work could devolve on no person so well qualified as is his distinguished son, Professor James Mills Peirce.—*L. W., in American Journal of Science.*

THE WHEAT MIDGE.

A FEW days ago we received some ears of wheat, with a request from the grower that we would inform him what had gone wrong with the crop. He said that until quite recently the plant had been going on in a most satisfactory style, and that he looked forward to a fine heavy crop; but he had since observed that many of the ears had turned quite pale, that the glumes had become somewhat dry and shriveled in appearance, and that when pressed between the fingers, the ear, instead of feeling firm and solid as it should in the middle of July, was thin and soft. The wheat was three-chested. We selected the middle floret of one of the spikelets, laid open the glumes with a needle, and brought a moderate magnifying glass to bear on the contents. The three shriveled stamens of the floret were still visible, but in place of the plump, green grain which should have been present, we saw an orange-colored mass of some soft substance. By aid of the mounted needle the colored substance was teased out, and was then found to be made up of a number of little maggots, each about one-sixteenth of an inch in length. The body was composed of a series of ring-like segments, like that of an ordinary worm, and each little grub had the bright orange-color already referred to. From within the glumes surrounding one grain we worked out no less than twenty of these grubs, while from another we obtained eighteen. The grain had been utterly destroyed, and nothing remained but a small brownish mass of decaying substance, and every grain was in an earlier or later stage of destruction.

Our readers are acquainted with the changes which occur in the life history of insects, or at least with the ordinary distinctive character of these changes; the egg, the larva (grub or caterpillar), and the perfect insect. The orange-colored grubs or caterpillars which we got out from the wheat grains are the larvæ of the wheat midge, *Cecidomyia tritici*. The eggs are laid on the stems of the young wheat plant, at about the time of flowering, by a gnat which is not more than from one-eighth to one-quarter of an inch long. As soon as the grubs are hatched out they find their way between the glumes of the flower, and in this early stage they are known as "red gum." It is said that the smoke from a burning couch heap is a good check at this period, which is not at all unlikely; therefore, if at about the middle or end of June there happens to be a heap of couch near a wheat field, it would be well to fire it on an occasion when the wind would take the smoke across the wheat. The grubs live on the juices intended for the nourishment of the grain, which is utterly destroyed, or becomes "tail corn." Many of them travel down into the soil previous to taking on the chrysalis form, which eventually gives rise to the little gnat which lays the eggs. Mr. J. B. Lawes, of Rothamsted, in his account of the wheat crop of 1878, states that the wheat in his experimental field stood up well at the time of cutting, but that, just before blooming, portions were covered by small gnats, which deposited their eggs in the ear, and these developed into small orange-colored maggots, which fed on the young grain. The unmanured crop came into ear some days later than the manured crops, and escaped injury from the fly, whereas the plot manured every year with fourteen tons of farmyard manure, suffered severely and yielded only about two-thirds as much grain as in 1868, when the weight of straw was about the same as in 1878.

There is no doubt that the yield of wheat in a crop may suffer to a very serious extent from the ravages of the wheat midge, while the quality may be depreciated as much as the quantity. We have not yet learned how to exterminate the wheat midge, but such precautions as are known should always be observed. It is a fact that the chrysalis is frequently carried away in quantities in the ears of harvested corn, and after thrashing the wheat it is to be found in the chaff. The question for the wheat growers is what to do with this chaff. If used as cattle feed, well and good, but if thrown about to decay, with the ultimate view of increasing the manure heap, then the grub is provided with good shelter all through the winter. The most radical remedy is to burn the chaff, when it is once ascertained that the chrysalides are among it. The destruction of the pest is then an absolute certainty.

It is a matter of common observation that late wheat suffers much less than early wheat. The latter is just in ear about the time the midge lays its eggs, and inside young glumes is the place it prefers for this purpose. By the time the late wheat is in flower this gnat has become scarce. The wheat midge usually confines its attacks to the wheat plant, but it does occasionally infest the barley plant, though fortunately this occurrence is rare. Farmers would render useful service if they would make notes of observations on its increase or decrease as influenced by the time of sowing, the period of flowering, any peculiarities of the soil and of the weather, and the mode of disposing of infested chaff.—*Mark Lane Express.*

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